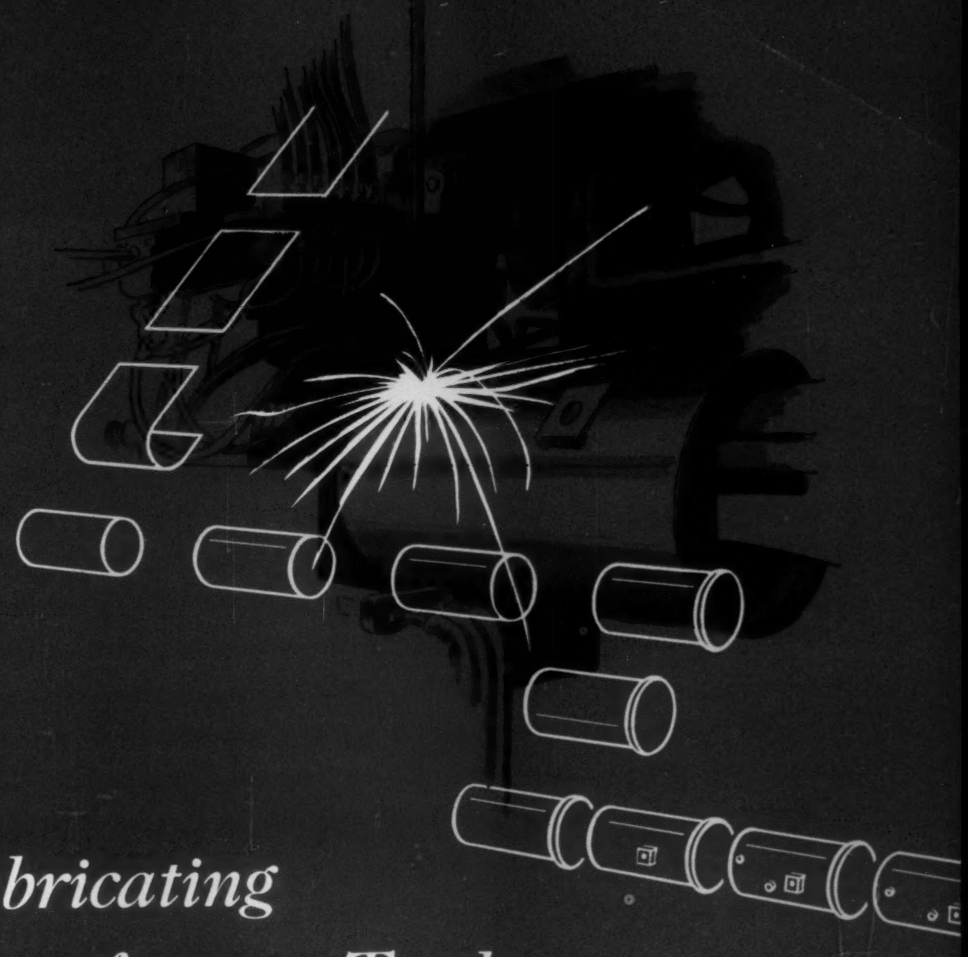
AUTOMATION

JULY 1959



Fabricating Transformer Tanks

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- Manufacturing Engineering and Machine Procurement
- Producing Coil Assemblies
- Modern Developments in Control
- Electrohydraulic Servo Valve Systems

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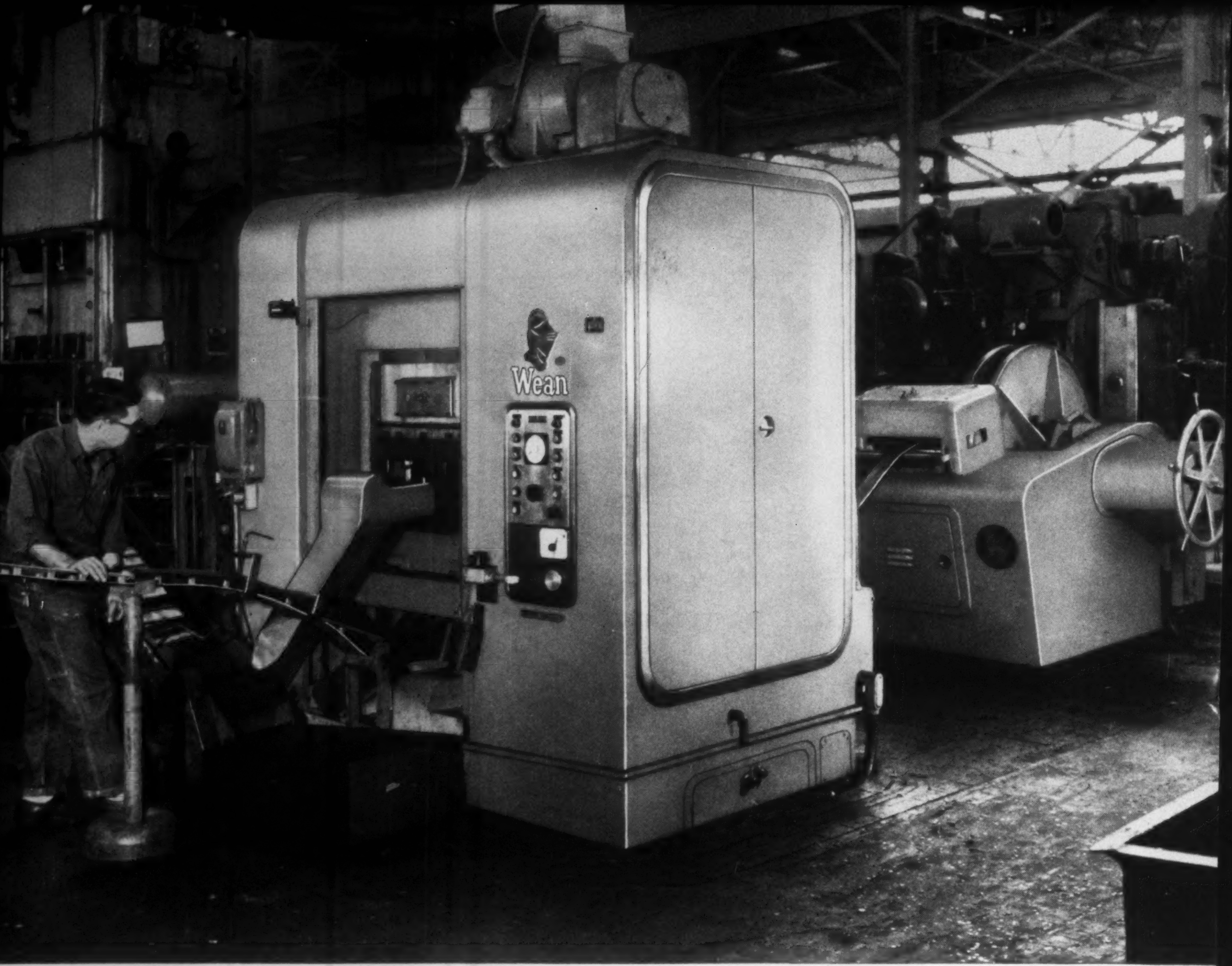
A PENTON PUBLICATION



At major automotive plant:

One Wean "Flying Press" replaces two conventional presses

This manufacturer used to produce transmission vanes on two conventional presses. Using seven-stage dies, these machines delivered the formed vanes at a combined rate of 308 parts per minute.

One specially designed Wean "Flying Press" now turns out the same part at 350 SPM, freeing the conventional presses for other work and reducing to one set the expensive dies needed. In addition, a tailor-made nest stacker now makes handling of the vanes a simple task. The firm estimates savings in operation and maintenance costs at upwards of 50%: a valuable bonus to increased production.

Many modern manufacturers have realized similar cost savings through use of the Wean "Flying Press" concept when quantity production, versatility and a high degree of press utilization are required. Won't you write for more information, or for a personal visit from a Wean sales representative? We are certain that he can help you find important potential savings in your production processes, too.

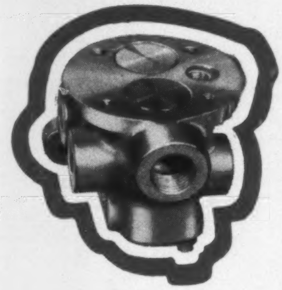
WEAN EQUIPMENT CORPORATION
CLEVELAND 17, OHIO
Detroit • Chicago • Newark

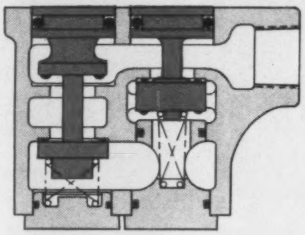
WEAN

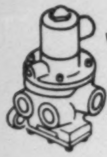
Circle 651 on Page 17

a basic Ross valve building block

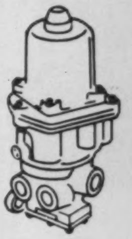
4-way inline mounted valve body



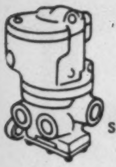




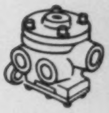
WHITEMODEL 4-WAY
¼", ⅜", ½", ¾"



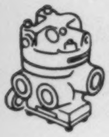
GOLDMODEL 4-WAY
¼", ⅜", ½", ¾"



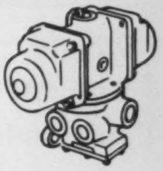
SILVERMODEL 4-WAY
¼", ⅜", ½", ¾"



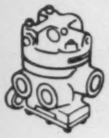
BLUEMODEL AIR OPERATED 4-WAY
¼", ⅜", ½", ¾"



BLUEMODEL TIMED-IN 4-WAY
¼", ⅜", ½", ¾"



GREENMODEL 4-WAY
¼", ⅜", ½", ¾"

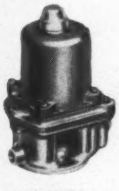


BLUEMODEL TIMED-OUT 4-WAY
¼", ⅜", ½", ¾"

- **Compact—saves space**
- **Ross quality**
- **Costs much less than base mounted 4-way**

Lots of designers use this valve where they must save space. It was designed specifically for compactness! Others use it to save money *without sacrificing* quality—when J.I.C. allows the usage of an inline valve, it meets J.I.C. specs. It's a unit of the Ross Skyline series which features modular construction, so it can be actuated with any Skyline series head. Ross poppet construction means pressure assists the seal, and short poppet travel gives faster response. On most applications it outlives the machine—and frequently doesn't even require maintenance. Write for Bulletin 321.

* WHITEMODEL SPOOL SOLENOID

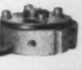


* GOLDMODEL OIL-IMMERSED SOLENOID

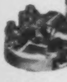
* SILVERMODEL JIC SPOOL SOLENOID

GREENMODEL DOUBLE SOLENOID MOMENTARY

BLUEMODEL AIR OPERATED

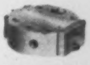


BLUEMODEL AIR-OPERATED MOMENTARY ADAPTOR



BLUEMODEL AIR-OPERATED TIMED IN

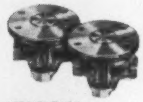
BLUEMODEL AIR-OPERATED TIMED-OUT



*THIS AIR INDEX ADAPTOR CONVERTS THESE HEADS TO MOMENTARY ACTION

"every head meets every body at this gasket"

ALL SKYLINE HEADS AND BODIES ARE BUILDING BLOCKS TO GIVE YOU MANY VALVES FROM A FEW HEADS AND BODIES



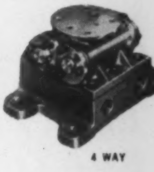
STRAIGHTWAY NORMALLY OPEN NORMALLY CLOSED

3 WAY NORMALLY OPEN NORMALLY CLOSED

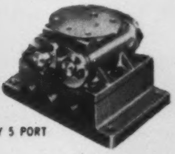
"featured above"

4 WAY

3 WAY NORMALLY OPEN NORMALLY CLOSED



4 WAY



4 WAY 5 PORT

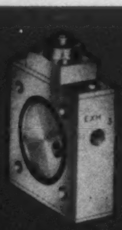
STAY AHEAD

MODERNIZE

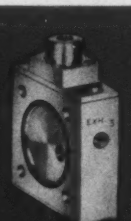
Ross OPERATING VALVE COMPANY
131 EAST GOLDEN GATE AVE. • DETROIT 3, MICH.

Palm Operated, Detented or Spring Return.

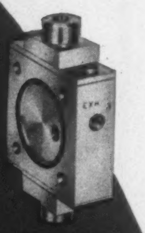
Lever Operated, Detented or Spring Return.



Ball Actuated Spring Return.



Pilot Operated Spring Return.

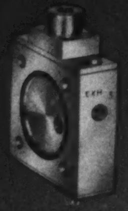


Double Pilot Operated.

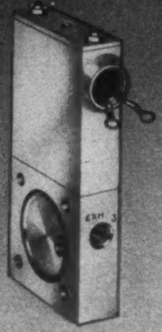
HUNT

new unique Slim Line

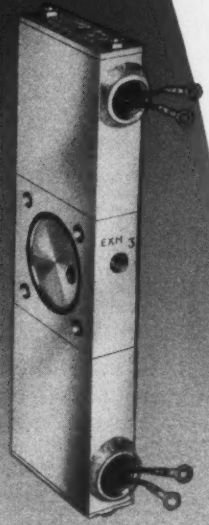
CONTROL VALVES



Pilot Operated Bucking Cylinder Return.



Single Solenoid Spring Return.



Double Solenoid Momentary Contact.

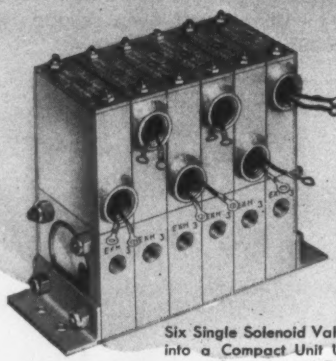
Now available with 8 types of operators. 3-way and 4-way actions. Easily manifolded into compact control centers.

● You'll like these new valves. Only 1″ thick by 3″ wide, they are exceedingly compact and light in weight; can be mounted easily on machines even when space is extremely limited.

Ideally suited for controlling small cylinders, to operate pilots and similar services. ⅛″ or ¼″ pipe tapped. Pressures to 125 p.s.i. Air, water, oil or vacuum service. Stock delivery.

Solenoid valves have the following features as standard; manual over-ride; ½″ NPT conduit connections; valve inoperative with solenoid cover removed.

The side of each valve is counter-bored, trepanned for an "O" ring, and provided with four through holes permitting up to eight valves to be manifolded together and operated from a single supply. Better get full details — now!



Six Single Solenoid Valves Manifolded into a Compact Unit Using Standard Brackets and Tie Rods.

More startling HUNT designs to come!

Send for the "SLIM LINE" Bulletin No. 581 TODAY!

HUNT
Slim Line
VALVES

40

HUNT

***Quick-As-Wink*® AIR AND HYDRAULIC**

CONTROL Valves

Manufactured by HUNT VALVE COMPANY, 2071 East Pershing St., Salem Ohio

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JULY 1959
Vol. 6—No. 7

AUTOMATION®

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The Magazine of
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Penton Building, Cleveland 13, Ohio

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automation outlook

ACTIVE PARTNER

". . . the work of Manufacturing Engineering is to determine the equipment, processes, tools, layout, methods, time standards, and facilities required to produce products when needed, in scheduled quantities, to specified quality levels, at lowest possible cost. The key words are *at lowest possible cost* because they immediately place upon Manufacturing Engineering the responsibility for being active rather than passive in the entire business organization. . ."—*Armin C. Frank Jr., Manager—Manufacturing, Vacuum Cleaner Dept., General Electric Co., see page 44.*

SHORT RUNS ARE THE RULE

". . . recent statistics show that 75 per cent of the metalworking industry is dealing in lots of 50 or less. Today's automatic machines often make 5 to 50 scrap parts before they are set up to produce usable parts. Electronic programming and gaging plus electrohydraulic control eliminate trial and error methods by constantly gaging in process. . ."—*R. J. Render, Electrohydraulics Staff Supervisor, Machinery Hydraulics Div., Vickers, Inc., see page 80.*

SUCCESSFUL APPLICATION

". . . after months of careful analysis and preparation, we have achieved a highly integrated data processing system. All principal facets of the business—sales forecasting, production, scheduling and reporting, accounts receivable, accounts payable, labor distributions, purchase order reporting and expediting, material costs and inventory—are combined into one unified operation, with current information available to all levels of management. . ."—*Robert Wright, controller, Mennen Co.*

THINGS TO COME

". . . in the field of solid state physics new materials will solve the problems of higher speed components for computing systems and other electronic devices, and it is predictable that speeds of component reaction will approach that of light. Costs of automated manufacture of module systems containing not only components, but the circuits surrounding them, will permit the development of computing devices rivaling in complexity and capacity the human brain. . ."—*R. G. Chollar, vice president, Research & Development, National Cash Register Co.*

THERE IS NOTHING PERMANENT EXCEPT CHANGE —*Heraclitus,* 513 *B.C.*

". . . in the growth of any organization, systems become antiquated even though the original concepts are usually sound and practical. They become outdated by the same factors that outdate us productionwise—technological advances—automation. . ."—*Lee R. Srigley, supt.; General Finishing Div.; Parke, Davis & Co.*

INDUSTRY-SPONSORED RESEARCH

". . . research often results in the discovery of better processes for making a known product. The primary objective of such work is usually to cut costs, but an improved product may also result, thus expanding markets and improving the competitive position of the sponsor. . ."—*Harold K. Work, dir., Research Div., College of Engineering, New York University.*

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BPA NBP

Circle 656 on Page 17→

... Fluid Power news

REPORT
NO. 12,105
NEW SECTION
AND DRIVE
IMPROVES
PRODUCT

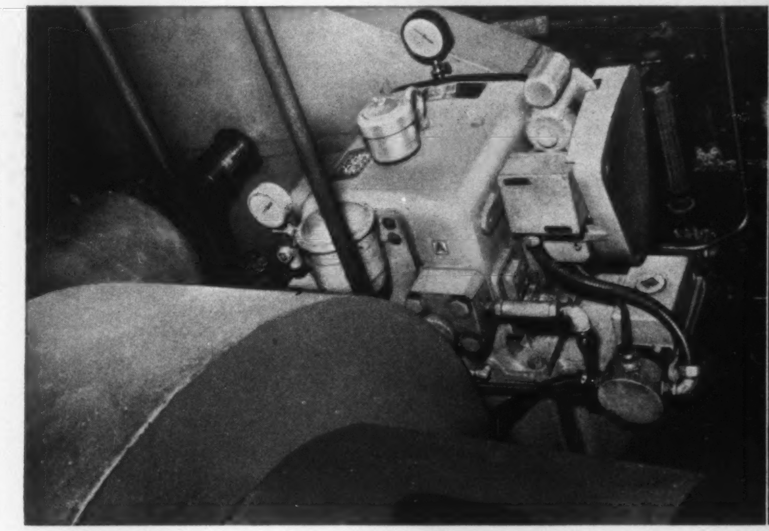
From Oilgear Application-Engineering Files

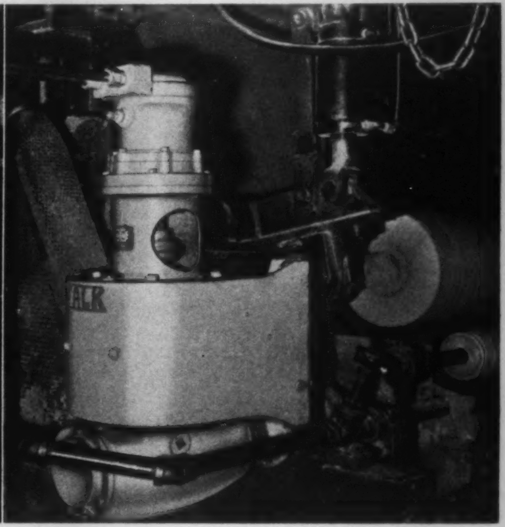
HOW OILGEAR HELPED SOLVE DRIVE PROBLEM FOR A NEW PAPER MACHINE SECTION

CUSTOMER: *A Large Midwestern Paper Manufacturer.*

DATA: To improve the finished surface of certain types and grades of paper, this manufacturer decided to insert a new sizing and smoothing section between existing sections of one of their paper machines. *Requirements: 1.* New section drive rpm must remain in same preset speed ratio with first dryer section roll regardless of over-all machine speed; allow precise, minutely controlled variation to increase or decrease wet sheet tension; hold constant speed within 6% regardless of increase or decrease of section roll pressures. *2.* Section drive to be inoperative at will without use of clutches . . . machine to operate with, or without the new section for dual purpose processing. *3.* Drive must be smooth, positive . . . without lag, shocks, or surges. *4.* Drive must fit within extremely limited, available space, and be direct-connected to new section sizing roll. *5.* Complete, individual control from a convenient, remote, push button station. *6.* Dependability, with a minimum of installation, or maintenance "downtime."

Note: A mechanical drive was considered, but space and control requirements would involve costly, major rebuilding of the entire machine.

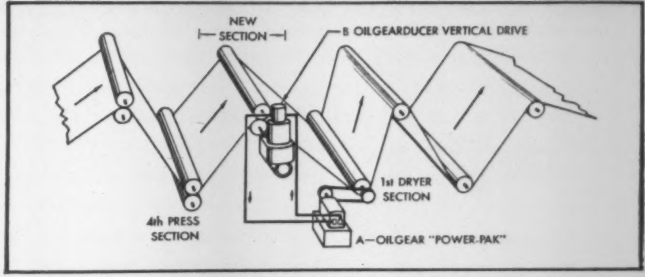




SOLUTION: Oilgear *Application-Engineers*, working in co-operation with company engineers, analyzed the speed, torque, control, and space limitations of this installation; and recommended an Oilgear "*Any-Speed*" drive consisting of a separate, heavy-duty, Oilgear pump and motor for the following reasons. *1.* An Oilgear Type "DE," Variable Displacement Pump with Electric Remote Control and Reservoir fitted into the very limited space available, and could easily be driven from the first dryer roll. *2.* A standard *Oilgearducer*—an Oilgear Constant Displacement Fluid Power Motor with integral right-angle gear reducer—could be direct-connected to the new section sizing roll. *3.* A simple pushbutton station for controlling this new section could be conveniently mounted on the opposite side of the paper machine. *Actual operation has proved that all initial requirements were either met or exceeded.*

Being a positive displacement drive, the direct-connected sizing roll rpm remains in the same speed ratio with the first dryer roll regardless of over-all machine speed. Original constant speed requirement—within 6%—is exceeded in actual operation . . . speed remains stable within 0.5% max. variation under full min. to max. load change. Two remote control station pushbuttons command the electric pilot control motor to increase or decrease pump displacement, changing the hydraulic motor speed and the section to machine ratio . . . precisely varying tension on the wet sheet. Section can be independently started and stopped from this station while the paper machine is running. Exact drive load and temperature are indicated. *In over four years of continuous, high-speed service, there has been no reported maintenance on this drive.*

This paper manufacturer has also Oilgear-equipped a laminator winder drive; the center winder on a super-calender stack; the unwind and rewind drives on another super-calender; five "wet-end" drives of another paper machine; plus other applications in the mill and powerhouse. This user, like many others in all phases of all industry, knows that *for the lowest cost per year—it's Oilgear!* Additional drive application data is available—Bulletins 10600, 10051-G, and "News" 3, 5, 8—on request, without obligation.



Oilgear Variable Displacement Pump (A) is driven from the first dryer section to keep the new sizing and smoothing press section speed in direct relation to the dryer section speed. Actual installation is shown in photo above, left. The small, geared-head pump control motor which changes pump stroke can be seen to the right of the pump. Controlled Fluid Power from the pump drives vertically mounted Oilgearducer (B), direct-connected to the sizing roll of the new section . . . as shown in photo above.

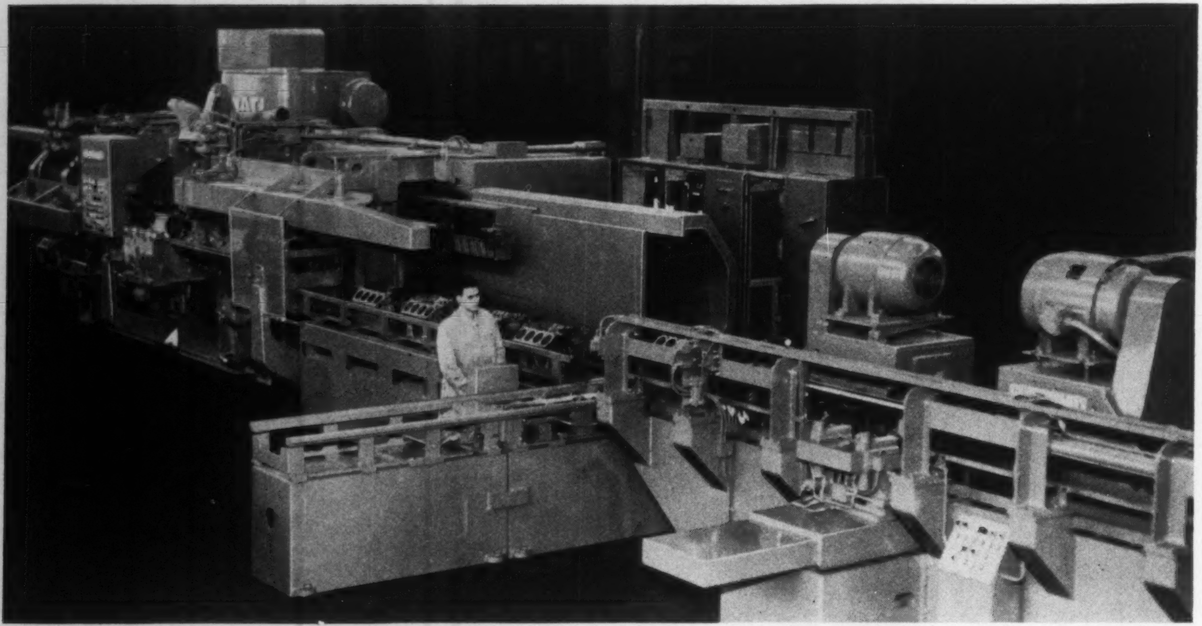
For similar practical solutions to YOUR rotary or linear drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY
Application-Engineered Controlled Motion Systems
1598 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN

CINCINNATI | SPECIAL MACHINE DIVISION

incorporates

in Cylinder Block Broaching



Broaching and milling of cylinder blocks are coordinated in this *dependable productivity* team of a CINCINNATI Horizontal Hydro-Broach and CINCINNATI Special Duplex Milling Machine.

The amazing records of the automotive industry are a tribute to the *dependable productivity* of CINCINNATI Horizontal Broaching Machines. Every major passenger car maker depends on these machines for cylinder blocks and heads. And many additional CINCINNATIS are broaching other parts such as exhaust manifolds, bearing caps, connecting rods, steering elements. The Special Machine Division quite often includes other Cincinnati machines in the *dependable productivity* plan, such as the Special Duplex Milling Machine teamed up with the Horizontal Broaching Machine (shown above). Broaching and milling proceed as a coordinated sequence of operations, at the rate of 100 blocks per hour.

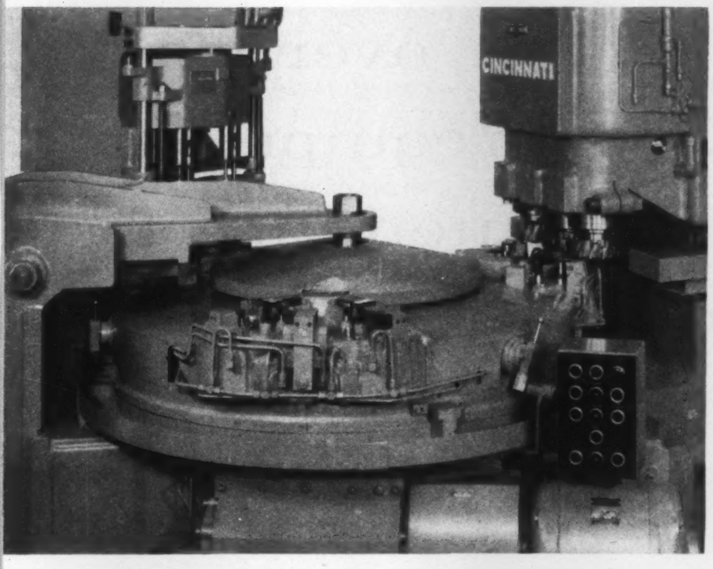
DESIGNERS AND BUILDERS OF SPECIAL MACHINES • VERTICAL AND HORIZONTAL BROACHING

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

DEPENDABLE PRODUCTIVITY...

and Milling Line

and in Rotary Table Multiple Operation Machines



Three dissimilar operations on exhaust manifolds are combined in one automatic cycle on this CINCINNATI special multiple operation machine.

Part name	Exhaust manifold
Material	Cast iron
Operations	Mill joint face, drill 7 holes, broach joint face
Production	112 per hour, at 80% operator efficiency

Production machines of this type have much in their favor: compactness; adaptability to changes in shop layout; push-button control; automatic cycling. The Cincinnati Special Machine Division incorporated all these advantages, plus a high degree of *dependable productivity,* in the multiple operation Rotary Table Machine at the left. It mills, drills and broaches exhaust manifolds in one automatic cycle.

A wide range of companies in many industries throughout the country have improved their operating performance and the quality of their products through the assistance of the Cincinnati Special Machine Division. Perhaps you too can find a solution to *your* cost-of-production problems, through our Engineering Service Specialists and our facilities for building cost-reducing equipment of any size.

MACHINES • COMPLETELY AUTOMATED PRODUCTION LINES

CINCINNATI®

SPECIAL MACHINE DIVISION

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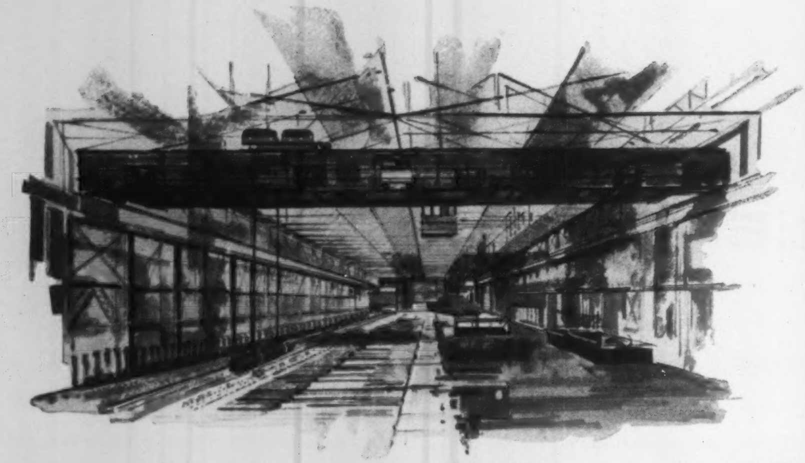

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Farval-Studies in Centralized Lubrication No. 241

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AUTOMATION news

Today's events and developments in the field of automation

Manufacturer Fights Foreign Competition With Automation

RISING to the challenge of competition from producers of household sewing machines in overseas low-wage areas, Singer Mfg. Co. has recently completed a major reorganization of its Elizabethport, N. J., manufacturing facility. Prime objective of the multimillion dollar modernization program was to adopt as many automatic production techniques as could be applied profitably to the manufacture of consumer sewing machines.

Extensive planning was required before Plant "X," as the new facility is called, could be justified economically. First step in the process was the complete redesign of the product with both producibility and customers' needs in mind. Three models were developed to include a minimum priced straight-stitching unit, a medium priced semiautomatic model capable of making decorative stitches, and an automatic machine which requires no insertion of discs to change stitch patterns. Where possible, components for all three models were made identical and interchangeable, thus providing for longer production runs on automatic equipment.

PRESSURIZED paint spray room at Singer Mfg. Co. contains six conveyor-fed paint booths equipped with Ransburg Electrocoating Co. Inc. electrostatic spraying units. Machine heads make three separate trips through the spray room, receiving two primer coats on the first trip and two enamel coats on each of the second and third trips. Between coats, heads are baked, sanded, and washed. Conveyor system was designed and manufactured by Mechanical Handling Systems Inc. working in conjunction with Singer engineers.

CONTROL panel for conveyor system programs parts carriers to various operations, eliminating wait time for operators on incentive production. Console contains warning lights that pinpoint locations of malfunctions on the eight integrated conveyors in system.

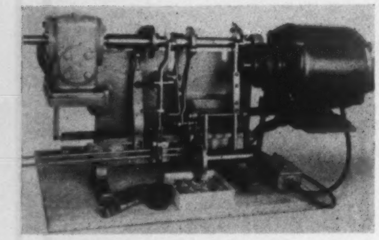
Review of all manufacturing operations involved in producing the three models revealed many opportunities to replace manual operations with automatic techniques. This, in turn, made it possible to consolidate operations from scattered multistory buildings into a single, one-story building, with advantages of lower overhead costs and improved control of operations.

Foremost among the equipment innovations was the installation of a \$400,000, 1½-mile long, electronically controlled conveyor system that carries parts and subassemblies through preselected machining, washing, drying, electrostatic paint spraying, and baking operations. An additional \$600,000 expenditure was invested in the electrostatic paint finishing system. Depending upon the size of units being processed, the sewing machine components are conveyed through the facilities at a rate of from 6 to 1500 units per minute.

The new conveyor system is an integrated one consisting of eight individual conveyors operating at speeds of from 6 to 40 feet per minute at five levels throughout the plant. The conveyors are interconnected by automatic transfer devices. The system as a whole is controlled through a central control panel, designed and installed by Singer engineers.

As a carrier proceeds on the conveyor, a flag on the carrier actuates preselected limit switches located at key points in the system. Position of the flag on the carrier is determined by what type of components are being conveyed. When a limit switch is actuated, an electrical signal is sent to the central control panel which automatically determines the routing of the particular carrier.

Automatic functions performed by the control system include: Segregating carriers of a given type for special processing; live storage of parts and subassemblies; sequencing of groups of carriers of the same type in a given order; and interposing empty conveyor hooks between groups of carriers. A "choking" provision also can be programmed to permit the accumulation of carriers at transfer points during off-shifts.



DUAL FEED cut-off machine has been developed by H & H Machine Co. Inc. for volume users of aluminum, copper, brass, or other copper alloy tubing up to 7/16 inch OD. Machine provides precision cutting of tubing into lengths up to 2 inches with a tolerance of plus or minus 0.005 inch. Depending upon the tubing OD and wall thickness, output of machine varies up to 12,000 pieces per hour. Unit also can handle certain plastic materials such as polyvinyl chloride, and other models are available for irregular shaped tubing, cut-off lengths longer than 2 inches, and round tubing up to ⅞ inch OD.

Westinghouse Develops Unique Germanium Growing Technique

REVOLUTIONARY new technique of growing germanium crystals as thin, uniform, flat ribbons instead of as round ingots has been developed by Westinghouse Research Laboratories. The process, a radical departure from conventional methods, is expected to eventually make possible the manufacture of transistors and other devices by automatic machines.

The new technique for growing germanium was the work of two Westinghouse research physicists, **Dr. R. L. Longini** and **Dr. A. I. Bennett**, who explained that the semiconducting material grows directly in the exact form in which it is used for practical purposes in transistors and similar devices. "The ease of processing dendritic germanium into usable form contrasts sharply with present practices," the scientists said. "To process conventional germanium ingots into useful form, they must be sliced into thin wafers. Because germanium is so hard and brittle, the cutting is done with a diamond-tipped saw, and each slice has to be three to five times the desired thickness simply to keep it from shattering.

"The slices must be ground down to the required thickness, further cut into small squares, and finally polished. Only then is the germanium ready to be fashioned into finished transistors or other devices.

Manufacturing Engineering Function Discussed At AMA Conference

CONCEPT of manufacturing engineering as a definite and distinct function of industrial management received new impetus as a result of a June conference held by the American Management Association at Montreal, Canada. This was the first technical program ever devoted exclusively to the newly-evolving function of manufacturing engineering in industry.

The three-day AMA Manufacturing Orientation Seminar discussed the topic of "Organization and Management of the Manufacturing Engineering Function," and helped set the groundwork for further development of the fundamentals of this rapidly growing function in industry. Conference chairman **Arthur J. Hatch**, management consultant of McKinsey & Co., keynoted the meeting with a presentation of the history, development, and scope of the manufacturing engineering function and discussed current trends affecting the status of the function. This was followed by presentations by key personnel of manufacturing concerns who outlined their company's approach to manufacturing engineering.

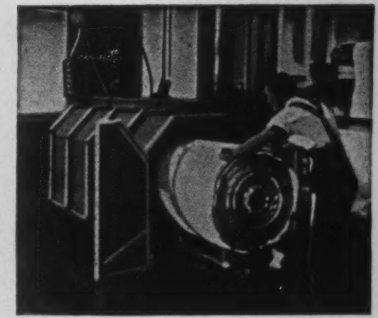
R. H. McCarthy, director of plant engineering for Western Electric Co. Inc., defined the objectives and management policies of Western Electric in applying the manufacturing engineering concept. Daystrom Corp., was represented by **Joseph Degan**, vice president of manufacturing for the Weston Instrument Div., who answered the question of what a chief manufacturing executive expects from manufacturing engineering in commercial and military products production.

The critical need for manufacturing engineering in defense procurement was discussed by **Edwin C. Nelson**, chief engineer for production, Materials Div., Bureau of Ordnance, Dept. of the Navy. Associate conference chairman **Richard E. Bennett**, manufacturing engineering manager for Daystrom Instruments, presented a method of organizing an effective manufacturing engineering program.

The key importance and need for before-the-fact manufacturing engineering when studying and carrying out automation projects was the theme of a presentation by **Roger W. Bolz**, editor, AUTOMATION, during the second day of the conference. **Col. O. S. Hulley**, consultant, Manufacturing Training & Education, General Electric Co., rounded out the program by discussing manufacturing engineering as a training ground for future managers, and he presented a program for staffing, training, and developing manufacturing engineering personnel.

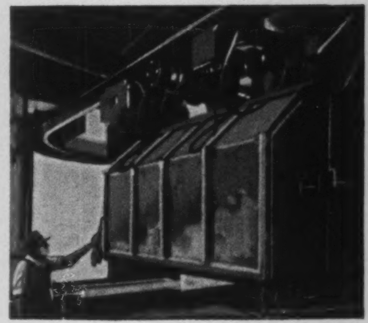
During the conference, discussion sessions covered in detail other areas of the manufacturing engineering concept such as functional versus project organization, collaboration with design groups, scope and training for introducing the function, centralized versus individual plant groups, and rational bases for evaluating the effectiveness of manufacturing engineering operations. These discussions effectively revealed the direction and key areas for future conference studies.

Louden Monorail
cuts the cost of
Interplant Transport



Operator loading carrier with two 650 pound beams of domestic print cloth prior to transport from loom room to cloth room.

Below:
Operator raising carrier into position, selecting destination by push button. Carrier automatically stops at desired destination.



Below:
Carrier completing trip automatically and unattended on 650 feet of Monorail from Plant #2 to Plant #1, leaving all streets and alleys free of congestion.

As companies grow and expand production facilities, the problem of interplant transport of materials, parts or semi-finished products is often encountered. Time and again Louden Monorail proves to be the perfect answer. With Louden's Selectomatic Control, such an interplant transport system can be virtually *automatic.*

The Louden Selectomatic Interplant Transport System at the Marion, North Carolina, plants of the Clinchfield Manufacturing Company is a good example. Here the problem developed of transporting tons of cloth daily between three separate buildings. 650 feet of Louden Monorail with a weather-proof car in almost continuous operation provides the perfect answer. The car can be raised and lowered as required for charging and discharging loads; the destination desired is preset by the control; transport is speedy, trouble-free, automatic. It is estimated three men with trucks would have difficulty doing the same job.

Louden Selectomatic Interplant Transport Systems can do many things not required in the Clinchfield installation described. It can automatically transport materials unattended from point to point anywhere in or about your plant, and it can select the shortest and most direct route to its destination. It can travel from floor to floor and building to building, open doors to let itself through and close doors behind it . . . building doors, floor doors, oven doors. It places loads in ovens or in banks of infra-red dryer lamps, turning the heat on and off as needed. It stops promptly when there is a load ahead or when it does not have the right of way, and resumes travel when the way is clear. It stops accurately at its destination and even loads and unloads its own carriers with certain classes of materials. It returns empty carriers to point of origin or places itself in storage awaiting its next call.

Louden Automatic Materials Handling is the guaranteed product of the pioneers and oldest company in the field of specialized monorail handling. Both the Louden field representatives and the factory engineers are highly trained specialists in the field of overhead materials handling. When you have a materials handling problem or any plant problem involving lifting and transporting loads, call on Louden for suggestions. This will cost you nothing but may prove to be the most profitable move you have ever made.

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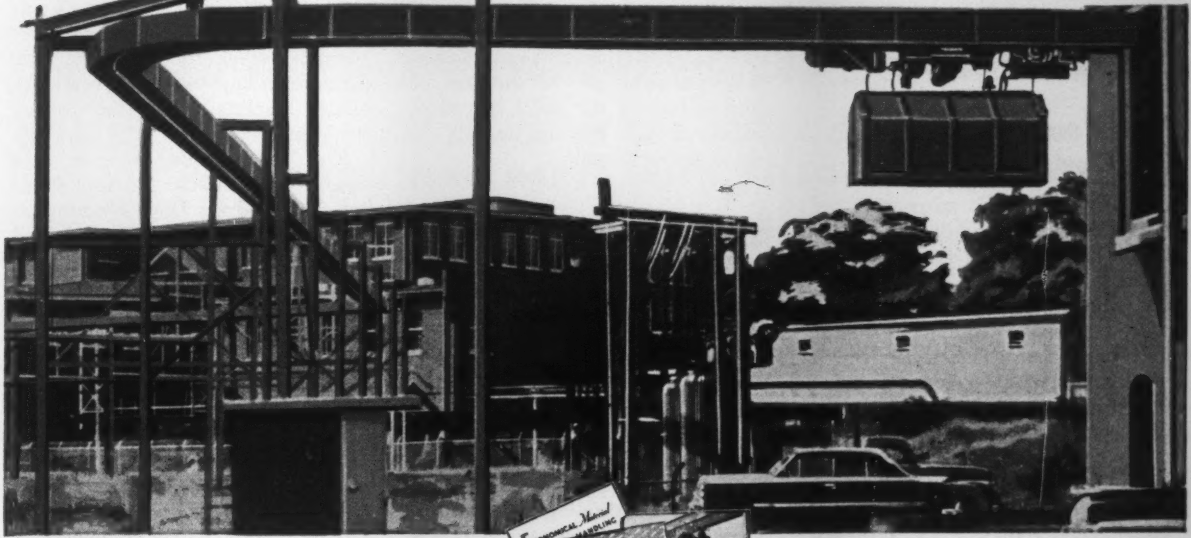

Get the latest information on the best in modern materials handling systems. Write today for your copy of "Economical Material Handling", a 52 page book full of how-to-do-it ideas. If you are interested in automation, ask for the new book on Louden Automatic Dispatch, "Automatic Materials Handling". With either you will receive the latest information on Louden Shok-Pruf Electrification, new safety in power for cranes and monorail systems.

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MONORAIL & CRANES

SINCE 1867 . . . THE FIRST NAME IN MATERIALS HANDLING

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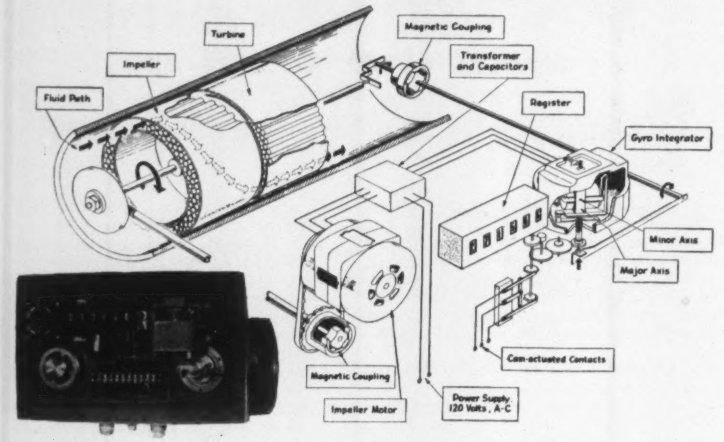
As a result of all this cutting and polishing, about 80 per cent of the original ingot is thrown away as sawdust.

"Not only is dendritic germanium of the proper thickness for direct use, its ultra-smooth, mirror-like surfaces need no grinding or polishing of any kind. As a result, the usual time-consuming and expensive processing of the germanium into usable form is virtually eliminated."

In commenting on the new development, **Dr. S. W. Herwald**, Westinghouse vice president in charge of research, said, "Dendritic germanium has broadened our thinking about the whole technology of solid state devices of the future. One can envision, for example, the process at work in a machine that continuously, automatically, and at high speeds turns out finished transistors directly from an input of raw germanium and two or three other materials required to put a transistor in final form." Westinghouse has been awarded a $2-million development contract by the Air Research and Development Command to continue work in the field of molecular electronics of which dendritic germanium is a part.



MASS FLOWMETER developed by General Electric Co. and Black, Sivalls and Bryson Inc. measures liquid and gas flow directly in pounds over a wide range of flow rates, pressures, temperatures, and densities. Schematic diagram illustrates operation of unit. An impeller is driven at a constant speed by a synchronous motor through a magnetic coupling. The rotating impeller gives an angular momentum to the fluid or gas as it enters the instrument. A fixed turbine removes this momentum and receives a torque proportional to the mass rate of flow which is transmitted to a gyro-integrating mechanism. The torque is applied around the minor axis of the gyroscope, causing the unit to rotate about its major axis at a rate proportional to the torque. This rotation is transferred through a gear train to a meter register where the mass flow is totalized and indicated in pounds. The gear train output also actuates a contact device which can be used to make or break an electrical circuit to operate remote counters, printers, and totalizers. Inset shows a mass flowmeter with the cover removed.

Metal Peening Method Uses Glass Beads

ELECTROSTATIC suspension of microscopic glass beads in a solution is being used in a new peening method developed by Aero-Test Equipment Co. Inc. The glass bead solution is used in equipment similar to other peening machines which use compressed air to force the solution through a valve gun.

The stream of glass beads strips away scale, corrosion, dirt, burrs, and tool marks, but does not remove or alter the dimensions of the basic metal. The elastic behavior of the glass beads prevents damage to sharp machined edges or fine gear teeth since the bead will either deform, assuming the contour of the surface, or shatter. This avoids denting of the metal, yet still performs the peening function. It also permits peening in a blind area, such as inside a valve case, without danger of damage or unequal treatment.

In addition to cleaning, the glass beads also seal the pores of a metal —leveling and surface working the metal for an increase in fatigue life and for finishes up to 4 mu. Variation can be made in the size of spheres, force of the peening stream, and duration of peening time to obtain a desired result.

IBM Corp. Reorganizes Data Processing Divisions

MAJOR reorganization of International Business Machines Corp. has been announced by **Thomas J. Watson Jr.**, president. Under the new setup, four new divisions have been created from two existing divisions. In addition, the new divisions plus two other existing divisions and a subsidiary corporation were placed in two newly-established corporate groups.

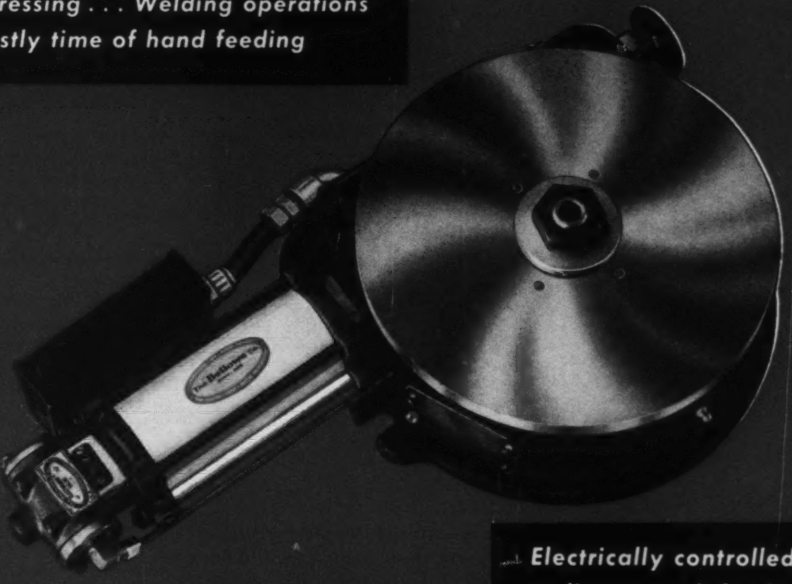
Three of the new divisions were created from the old Data Processing Div. Their titles and functions are as follows: 1. Data Systems Div. will develop and manufacture large scale electronic data processing systems. 2. General Products Div. will develop and manufacture intermediate and small computing systems, and punched card accounting machines. 3. A new Data Processing Div. will lease, or sell, and service the complete line of IBM punched card accounting machines and electronic data processing systems for all domestic markets except the federal government.

The fourth new division was formed from the old Military Products Div. and the IBM Washington Federal Office. This division will engineer and produce special military data processing systems and market commercial data processing systems to government agencies.

Previously announced was the formation of another new division, the Advanced Systems Development Div., which will design and engineer commercial machine systems for undeveloped information handling areas. This division will also explore new applications made possible by advanced technologies.

Under the new corporate structure, **T. V. Learson** will be vice president and group executive for the Data Systems Div., General Products Div., and Advanced Systems Development Div. **McLain B. Smith** will hold the same title for the Data

Automatically positions work pieces for your Drilling . . . Tapping . . . Reaming Milling . . . Pressing . . . Welding operations Saves the costly time of hand feeding



Electrically controlled, rotary or linear work feeders are easily installed, readily synchronized with any machine cycle

QUALITY CONTROL CAN BEGIN AT THE POINT-OF-OPERATION WHEN YOU FEED PARTS WITH BELLOWS WORK FEEDERS

You will have many more acceptable parts at Final Inspection if you examine work pieces at the point-of-operation. To give machine operators time for visual inspection, feed parts to tools with Bellows Work Feeders. The operator will then have time to load at one station, unload and examine a finished part while his machine continues to work. Not only will there be time for examination of the machined part but you will be able to use more of the machine's producing ability. The tool won't be standing idle while the operator loads and unloads.

Bellows Work Feeders are made in both rotary and linear type models; different units designed for high speed parts positioning where tolerances are not critical, or precision indexing types where close accuracy is required.

Air-Powered, electrically controlled, they are easily installed on standard machine tools, can be readily synchronized to work with the basic machine cycle.

To cut machining costs . . . keep the machine working while you load or unload a fixture.

Bellows
ROTARY WORK FEED TABLES
ROTARY INDEX TABLES

These Bulletins give you the Facts

Write for Bulletins RT 1022 and RT 1326 for full specifications and application data on Bellows Work Feeders. Address Dept. AU-759, The Bellows Co., Akron 9, Ohio. In Canada, Bellows Pneumatic Devices of Canada, Ltd., Toronto 18, Ontario.

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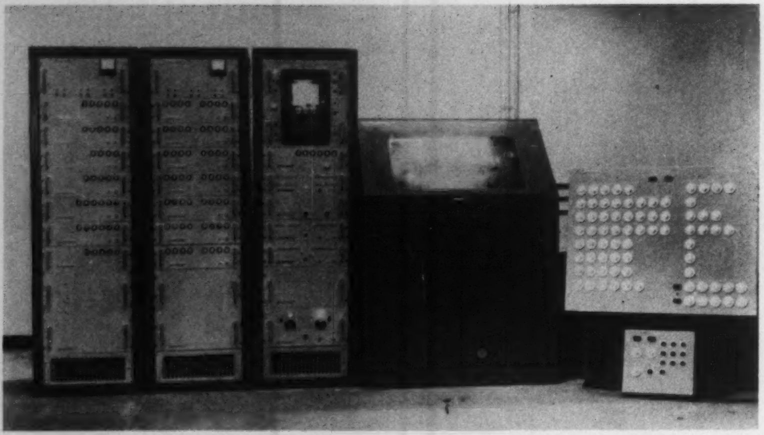

AUTOMATIC equipment developed by Systron Corp. was recently installed in a major steel mill for in-process inspection of steel being coated with tin. The system scans the coated strip, moving at speeds up to 1500 feet per minute, and provides for visual readout and a typewritten record of pinhole defects and variations in the tin coating thickness. For each coil processed, the unit computes and records the total weight, total length, and prime usable length. Defect information is stored and is used to control subsequent shearing operations for cutting out defective lengths. The system also automatically controls the coil loop in the dip tank and loop pit. Location of defects is recorded on a strip chart for later analysis of the process.

Processing Div., Federal Systems Div., Supplies Div., and the Service Bureau Corp., a wholly-owned, independently-operated subsidiary of IBM.

General Electric Establishes Advanced Engineering Center

NEW DESIGNS in equipment and components for the conversion and inversion of electric power by static means will be explored by General Electric Co. in a new Direct Current Advanced Engineering Center recently established in Philadelphia, Pa. The Center is an organizational component of General Electric's Low Voltage Switchgear Dept.

The new Center will stress development of silicon semiconductor and mercury-arc power equipment for electrochemical, steel, and aluminum industries. In addition, extensive work will be conducted in developing power controlled rectifier equipment for application in highly regulated industrial and military dc power supplies.

Several major laboratories are housed in the 20,000 sq ft of working space. These laboratories include chemical, metallurgical, measurement, and crystallographic facilities which will be used to develop silicon semiconductor rectifier equipment and circuitry to be incorporated in packaging complete power supplies, including instruments, switches, controls, fuses, and protective and regulative devices. The metallurgical laboratory houses facilities for investigating and analyzing fabrication welding and soldering of rare metals. Other facilities in the Center include an electromechanical laboratory for the development of mechanisms for dc power circuit breakers, an engineering laboratory containing analog computers for studying parameters of electric circuits, and a life test and load test center.

Machine Replacement Data Offered In New Booklet

LIMITATIONS and fallacies in many commonly used machinery replacement formulas are pointed out in a new booklet offered by Jones & Lamson Machine Co. Called "Avoidable Costs Replacement Formula," the 12-page booklet describes a realistic method of justifying proposed investment in new equipment by using a projected increase in labor, material, and equipment cost during the estimated life of the proposed new equipment.

Included in the booklet are tables listing multiplying factors for determining wage and material increases over a 10-year period, and replacement cost factors for metal

ANNOUNCING . . .

The Birth of a New Era in Small Air Control Valves

by: WILLIAM CARLS, President, Numatics, Inc.

The last five years have seen air controls expand into countless operations where automation was once considered impossible or uneconomical. Most of these operations involve cylinders of 3¼" bore or smaller.

In these applications both the physical size and the cost of the valve are vitally important, and the wasteful practice of overvalving, using a valve of considerably greater capacity than needed, cannot be tolerated. So, more and more, these systems are being *engineered* rather than being just built.

Engineers, however, have been handicapped by the lack of well-engineered *small* valves. Up to now, small valves have gained smallness by sacrificing adequate wiring space, sub-plate and manifold mountings, manual operators, and compliance with JIC Standards. In many cases the all-important double solenoid momentary contact action simply was not available. And too often basic valving action was not heavy duty and wouldn't stand up under multi-million cycle demands.

Two years ago Numatics started development of a family of small 4-way valves for this field. Objective: to produce a well-integrated group of compact valves which would offer the heavy duty ruggedness of our famous patented lapped spool-floating sleeve action in a variety of housings, mountings, and options to cover the entire field, from a basic valve at a rock-bottom price, to a manifold assembly with all the features required by JIC Standards.

The result of two years of intense work is our new "SA JUNIOR" Series . . . a ¼" valve with capacity to operate a 3¼" bore cylinder at a piston speed of one foot per second, capable of doing about 60% of all valving jobs in the average plant, yet so small physically, and so modestly priced that it might well cut your air valve costs by 40%!

Our new catalog SAJ-59 tells the complete story of SA JUNIOR and a copy is yours for the asking. Just send the coupon below.

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HIGHLAND, MICHIGAN

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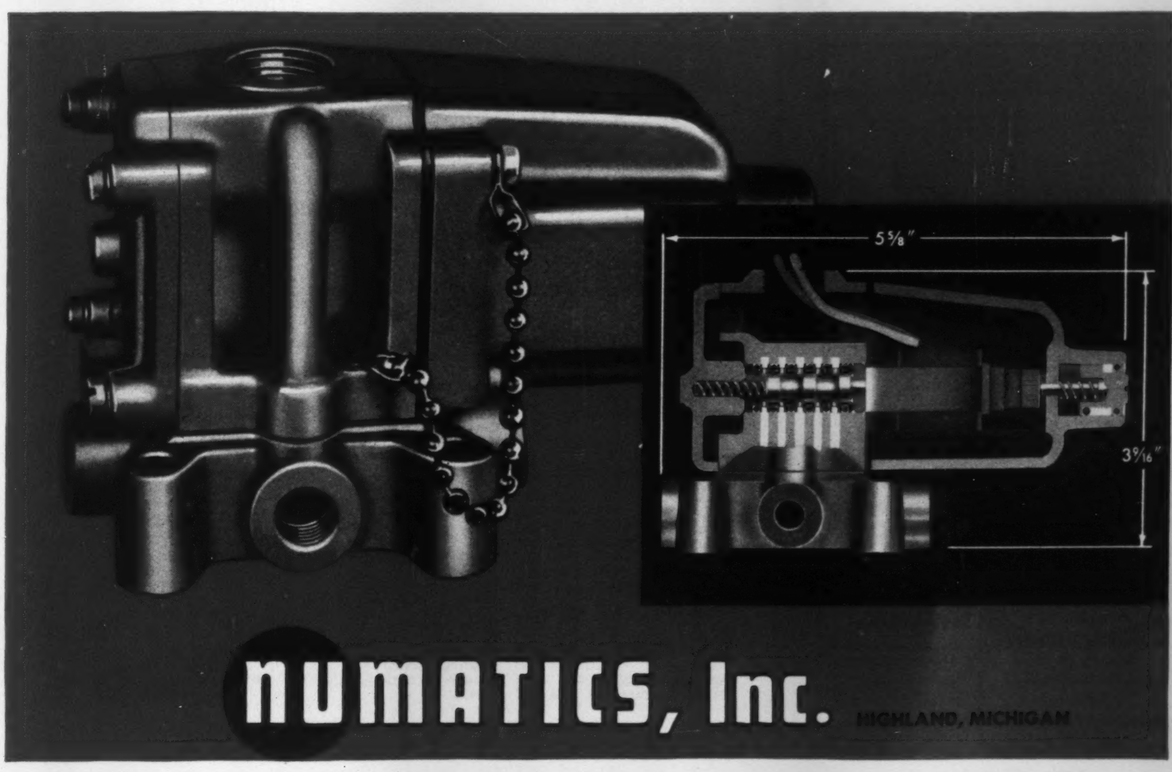
Circle 661 on Page 17

INTRODUCING . . . SA JUNIOR

Numatics' new family of SMALL, heavy duty air valves and manifolds . . . so small the valve nestles in the palm of your hand . . . yet so powerful that it can handle 60% of *all* air jobs in the average plant . . . and at a *fraction* of the cost of conventional valving! The SA JUNIOR Series is a *complete* system of *small* valving . . . single solenoid and double solenoid momentary contact (detented) actions . . . a variety of models and options to suit any installation need . . . three different sub-plates, four styles of low-cost manifolds . . . three types of manual operators, optional quick-disconnects on the solenoid leads. SA JUNIOR truly gives you a flexibility unmatched anywhere in the air valve field! JIC Standards? Absolutely . . . with a novel new "Solenoid Capsule" construction which for the *first* time eliminates the plague of loose parts when the solenoid cover is removed. Two years in development, SA JUNIOR uses Numatics' famous patented lapped spool-floating sleeve valving action . . . the toughest, most trouble-free action ever developed. Guaranteed to give you years of maintenance-free money-saving service. For details call your Numatics representative. We'll be happy to supply his name and phone number.



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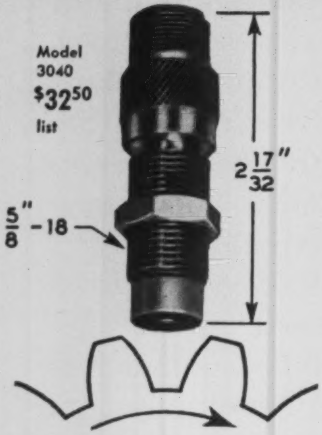

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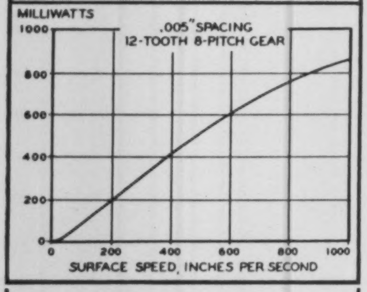

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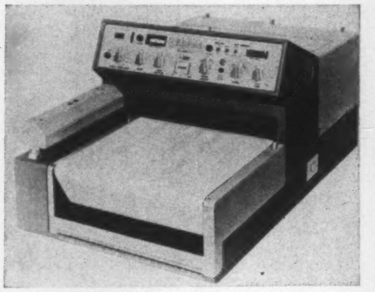
working machinery over the same period. These tables are based on data developed by the Bureau of Labor Statistics, U. S. Dept. of Labor. Two illustrations of equipment replacement computations are included in the booklet. Copies of the booklet may be obtained by writing to Jones & Lamson, Springfield, Vermont.



DIRECT recording-readout oscillograph developed by Midwestern Instruments can record up to 50 channels of test data on a 12-inch wide chart. Recording speeds are variable from 0.05 to 170 inches per second. Using light-beam type galvanometers with responses up to 6000 cps, the recording beams contact the paper in full view of the operator. Data traces are made visible by secondary exposure of the trace to low intensity light such as fluorescent room lighting. Full width timing lines and longitudinal grid lines are also optically produced simultaneously with the test data, eliminating errors in timing and data correlation.

Mail Sorter Developed For Private Business Use

CONSIDERABLE research and development has been sponsored by the Post Office Dept. to speed up the handling of public mail with automatic sorting machines. However, due to the high cost and specialized features of these machines, they have not been practical for private business use in sorting bulk-rate mail.

Recognizing this problem, Circulation Associates Inc. and Universal Business Machines Inc. have developed a mechanized mail sorting machine exclusively designed for industrial use. Called the Keytronic, the machine can sort 6000 mailing pieces per hour as compared to approximately 1000 pieces per hour by manual sorting methods.

The sorting machine has 44 bins, each having an average capacity of 180 mailing pieces. Mail is placed in a feeding trough, and an oper-

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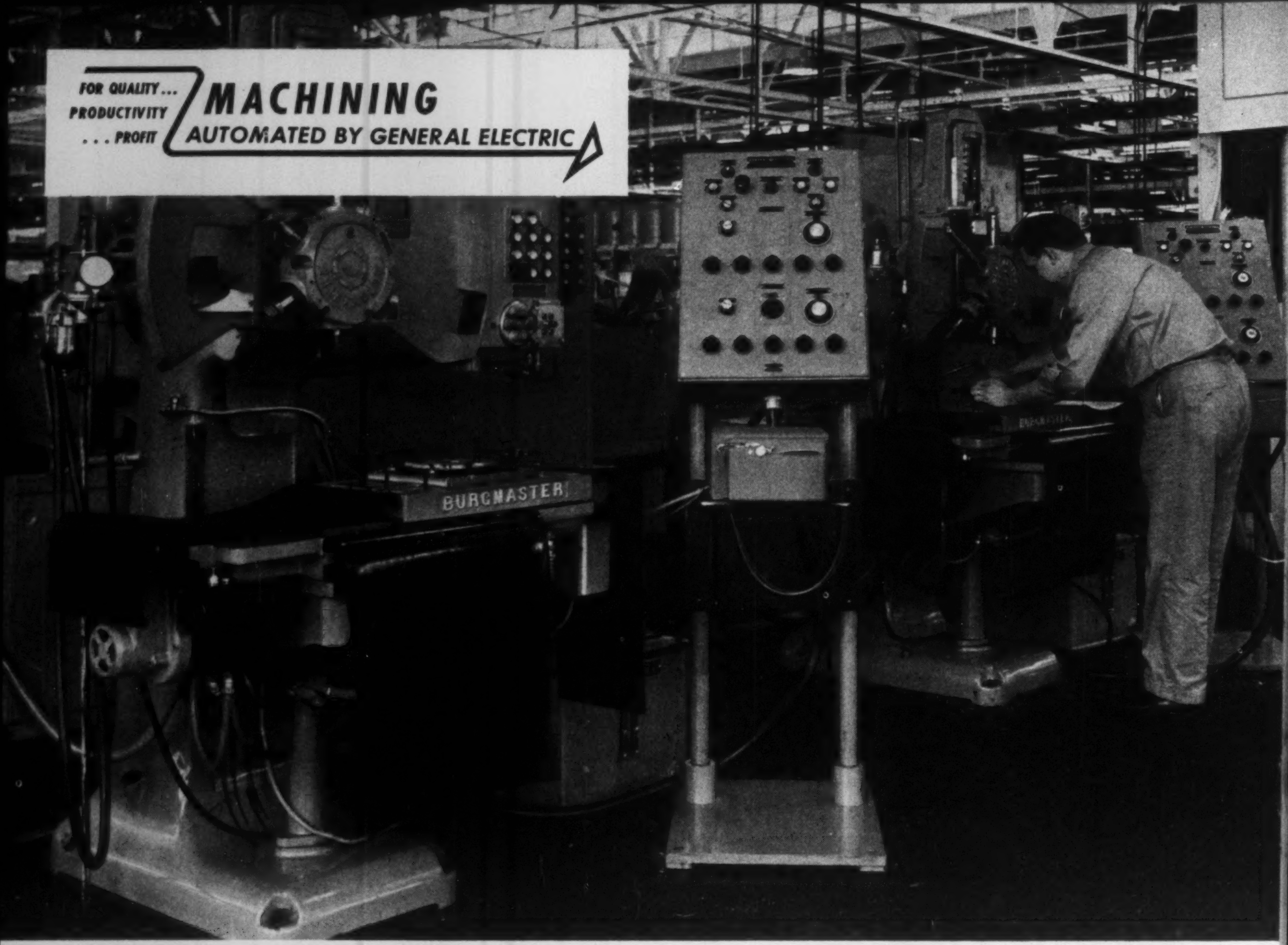
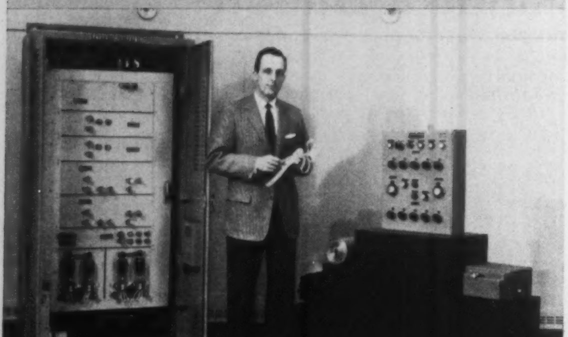


INCREASE WORKER PRODUCTIVITY

MARK SERIES NUMERICAL CONTROLS...



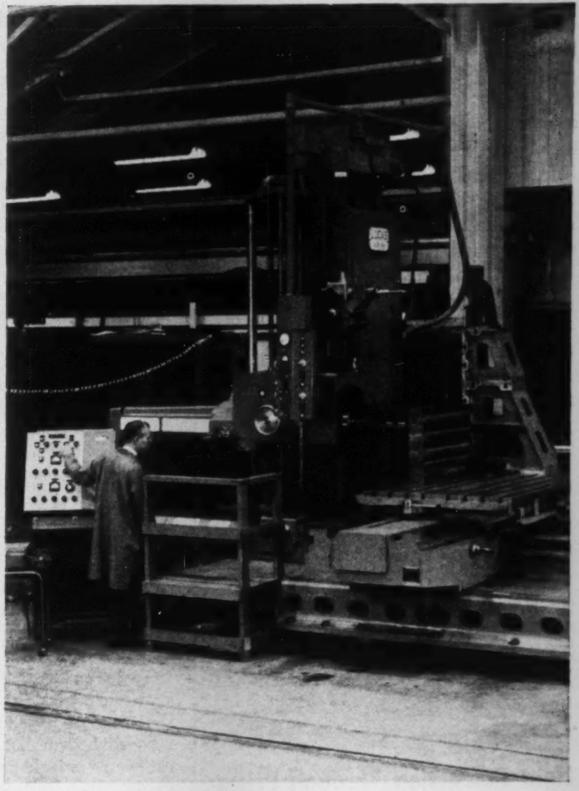
...... standard, job-proved packages now in use on a wide variety of machines

General Electric's Mark series of standard, pre-engineered numerical control packages—with systems for controlling 1 to 5 motions plus machine auxiliary functions — are compiling impressive performance records on scores of machines throughout American industry today.

Machine operation is completely automatic—from punched tape prepared on a standard automatic typewriter. If desired, semi-automatic positioning, useful for prototype work, is obtained with manually set dials on the control station.

Key components of a typical Mark package are a controller, a punched tape reader, operator's control station, servo drives and position-sensing units.

8-TO-1 TIME REDUCTION in press operations is achieved on this 100-ton rotary-turret punch press directed by General Electric numerical control. Rapid positioning of table and turret provides up to 40 punches per minute.



40% AVERAGE TIME REDUCTION for all parts produced on this horizontal boring machine means greater output and better equipment utilization. Lead times are cut by 8-to-1, and non-productive worker time is reduced by more than 60%.

with General Electric numerical control

Boost output of man and machine, reduce in-process inventory

Over the past 7 years, management has seen labor costs increase by 50% with productivity up by only 15%. This profit-cutting gap has accelerated an industry-wide need for production methods such as General Electric numerical control.

Key benefits of G-E numerically controlled machines include increased worker output, increased machine utilization, and reduced in-process inventory in virtually every job.

Manufacturers are now realizing far greater output per man-hour . . . faster "pay-back" rates on machines . . . shorter production cycles . . . and much lower inventory investment—in itself justification for numerical control. Here's an example:

Automatically controlled turret drills are used to produce aircraft-engine accessories at Chandler Evans Corporation, West Hartford, Conn. With numerical control, direct-labor costs have been cut in half! The machine operator—working two machines simultaneously—loads the piece, sets the machine in operation, and all production is performed automatically. But, increased productivity is only part of the story. Scrap losses are virtually eliminated, average lead times are cut by 6-to-1, cutting-tool costs are 1/40th of former production methods, and tool life is increased from 30 to 1300 pieces per tool—all adding up to expected *annual* savings of $42,000, more than enough to pay for both machines within two years.

Join with Chandler Evans and hundreds of other manufacturers who are increasing productivity, gaining better product quality, and eliminating tooling cost with G-E numerically controlled machines. See your G-E Apparatus Sales Engineer or machinery builder today. General Electric Co., Specialty Control Dept., Waynesboro, Va. 795-7

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GENERAL ELECTRIC

Circle 664 on Page 17

ator reads the destination by state, city, or zone, depending upon how fine a breakdown is required in the first sort. The operator then transforms the destination into a code number which he enters into a keyboard on the machine. The piece of mail is then automatically conveyed and dropped into one of the 44 receiving bins. After the first sort of 44 separations, each separation can be sorted again into 44 parts, making it possible to sort 1936 destinations in only two passes through the machine.

Production of the sorting machine will begin late this summer. Various models will be able to handle mailing pieces ranging from 2½ by 3 inches to 11½ by 12 inches. The machine itself will only be 10 feet long since the receiving bins are tiered in two horizontal rows to conserve floor space.

Light Refraction Through Prism Operates Liquid Level Sensor

PRINCIPLE of refraction of a beam of light by an optical prism has been used by Bendix Aviation Corp. in the development of a unique liquid level sensing device. Although primarily developed for use in missile systems, the electronic sensor can be applied to industrial systems to sense the presence of liquids and any change from liquid to gas or vice versa.

The complete sensing unit is built into a probe and consists of a light source, optical prism, silicon solar cell, miniature transistor amplifier, and a double-pole, double-throw relay. For specific applications, the amplifier and relay can be separated from the probe.

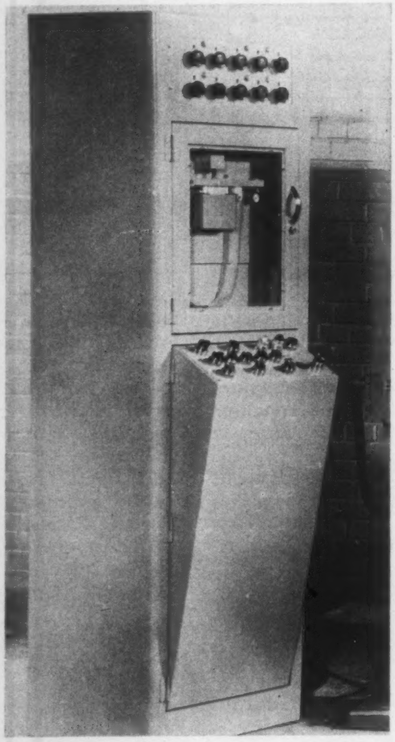
The device is operated by light rays from a miniature bulb. The rays are directed into the prism, reflected internally from the two 45 degree surfaces of the prism, and transmitted up to the solar cell which is located parallel to the light source. When the prism end of the probe is immersed in liquid, the refraction of the light rays is changed so that the rays pass directly into the liquid without internal reflection. When the prism is in

Positioning Control System Uses Pneumatic Tape Reader

POINT-TO-POINT positioning control system, developed by Sperry Gyroscope Co. of Canada Ltd. for machine tool applications, incorporates several new design and operational features. Highlights of the design feature a combination of analog and digital techniques to obtain maximum benefit from both design philosophies, a linear electrical scale and slider for measuring workpiece or table position, and a pneumatic tape reader.

The control system accepts numerical information coded on 1 inch wide, 8-channel punched tape, prepared on any standard preparation machine or by a hand punch provided by Sperry. No alphabetical coding is required by the system. Input to the system is through a pneumatic tape reader which reads a 2-inch block of tape instantaneously and eliminates the need for shift registers or memory units. Each data block contains command instructions for one table position plus any auxiliary functions required. Manual data input can be provided by setting banks of decade switches for each controlled axis.

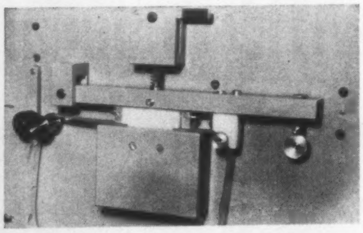
Table or tool position is sensed by linear electrical scales consisting of a stator and a slider. The stator is fabricated from flat bars of a glass/mica compound which are plated with a series of fine lines in the shape of an elongated coil. Several stator bars are series connected to form one continuous coil. The slider is similar to a single stator section and has a series of 25 separate coils plated on it, each coil covering about 0.25 inch.



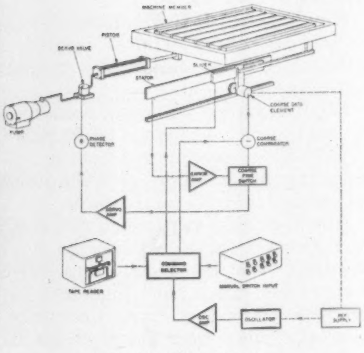
The slider is rigidly linked to the moving machine member and rides over the stator with a few thousandths of an inch clearance. Low frequency ac excitation of any one coil on the slider will induce an approximately sinusoidal signal in the stator coil. This signal will be at full amplitude when the energized slider coil is exactly aligned with the stator coil and will fall off when the coils are misaligned. Null points can be electrically shifted in increments of 0.001 inch by selecting slider coils.

In practice, a coarse data element geared to a small rack is used to bring the machine member to within about 0.050 inch of desired position. Preselection of an appropriate slider coil establishes a null at the desired position, and the member is driven in fine travel to this null. Precise positioning to 0.001 inch with an accuracy of ± 0.0005 inch and repeatability of ± 0.0001 inch can be achieved with this system.

Sperry has developed a new electrohydraulic servo valve which is ideally suited for actuating hydraulic cylinders. Use of valve provides a rapid, accurate drive system without the necessity of ball screws, roller ways, and other mechanical means to overcome friction and inertial problems. An important advantage of this type system is that it does not require mechanical locking devices to maintain a position once it has been reached.



Pneumatic Tape Reader.



Positioning Control System.

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3-way, high-flow, solenoid valves for general industrial use

SKINNER ELECTRIC VALVES

Main orifice sizes: full effective—⅜″, ½″, ¾″ for ⅜″, ½″, ¾″ NPT.

Standard operating pressures: 5 to 150 psi.

Media: oil, air, water, vegetable and petroleum oils, inert gases, kerosene, gasoline.

Types: normally open, normally closed and directional control in standard and explosion-proof construction.

These new, 3-way L3 Series valves, like all Skinner valves, are built to UL standards. Their bodies are made of forged naval brass and their internal parts are stainless steel and brass. Soft, synthetic inserts and seals provide bubbletight sealing. And a unique, Buna-N coated nylon diaphragm assembly assures long life. The valves are compact, light, and mount in any position, directly to the line. They are offered in a wide range of voltages and frequencies, with many electrical options and manual override.

Typical applications: air vises, chemical process equipment, presses, water treatment equipment, industrial machinery, packaging machinery, air and hydraulic cylinders, laundry machinery, etc.

Skinner solenoid valves are distributed nationally.

For complete information, contact a Skinner Representative listed in the Yellow Pages or write us at Dept. 327.

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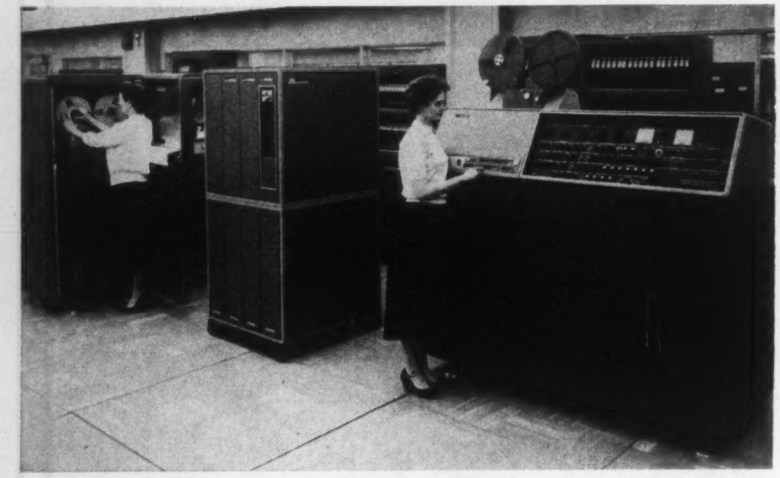
SKINNER ELECTRIC VALVES

THE SKINNER ELECTRIC VALVE DIVISION • NEW BRITAIN, CONNECTICUT

Circle 665 on Page 17

a gas, the rays are internally reflected to energize the solar cell.

The electronic sensor will function efficiently in many fluids such as liquefied gases, hydrocarbon fuels, red fuming nitric acid, fluorides, hydrazine, water, ink, and molasses. Operating voltage is 28 volts dc, and the contact rating of the relay is 3 amp at 28v dc or 115v ac.



MICROFILM printer installed in the Baltimore office of the Bureau of Old-Age and Survivors Insurance, Social Security Administration, converts data coded on magnetic tape directly to readable records on 16mm microfilm. Designed and built by the Special Engineering Products Div., International Business Machines Corp., the machine can print at a rate of more than 3000 lines a minute—each containing 120 characters. The Bureau is using the printer to keep its National Employee Index up-to-date. This Index contains information on the 130 million social security card holders. Coded information read by either of two magnetic tape units, far left, is extracted by a printer control unit, center, which translates it to alphabetic and numerical characters. These data are displayed on the face of a cathode-ray tube and microfilmed in the printer at the right.

Computer Accumulates Data On a Tinning Line

INCREASED efficiency and greater reduction in time required to collect and tabulate important product information are anticipated by the Fairless Works of the United States Steel Corp. in Fairless Hill, Pa., as a result of the recent installation of a new General Electric Co. GE 302 data accumulator. The computer system, operating in conjunction with other equipment, accumulates product data on a tinning line.

One feature of the system is a magnetic drum technique that provides two completely separate and independent sections for accumulating and storing data. These two sections operate in parallel and continuously check each other. If one section fails, the other continues to accumulate, store, and print correct information. Maintenance and repair can be accomplished on the inoperative section without shutting down the entire system.

Nail Packaging Machine Uses Round Steel Strapping

HIGH SPEED packaging machine that automatically delivers and straps cartons of nails for shipment has been installed at the Donora Works of the American Steel and Wire Div., U. S. Steel Corp. The installation was engineered and installed by the U. S. Steel Supply Division to replace two semiautomatic machines formerly used at the nail mill.

The packaging machine receives packages from four nail conveyor lines in seven different sizes of cartons with only minor adjustments required by the single operator. In addition to other economies inherent in the packaging system, the automatic machine uses high tensile strength round steel strapping which permits strapping material savings of more than 45 per cent per hundredweight of nails packaged.

SPOTLIGHTING PEOPLE

Robert L. Jackson named production manager for Scientific and Process Instruments Div., Beckman Instruments Inc. . . . **Ed Laxo** joined the Container Div., E. W. Bliss Co. as special machinery designer . . . **Robert L. Casselberry** named acting manager of the Technical Products Operation, Communication Products Dept., General Electric Co. . . . **Richard K. Schrecongost** joined Greenlee Bros. & Co. as a consultant on die casting machines and has been assigned to a subsidiary, B & T Machinery Co. . . . **Ernest A. Siemssen** appointed chief engineer for the Automatic Machinery Div., Selas Corp. of America . . . **William J. Thayer** named assistant chief engineer of Moog Servocontrols Inc. . . . **Victor Frederiksen** appointed manufacturing engineer on the central staff of Detroit Harvester Co. . . . **Harold A. Mosher,** assistant director of engineering for Eastman Kodak Co., elected president of the National Society of Professional Engineers . . . **William D. Macgeorge** named chief engineer of Tatnall Measuring Systems Co., subsidiary of the Budd Co. . . . **Alexander Greenfield** appointed vice president—engineering of Teleregister Corp. . . . **John E. Erskine** elected president of Racine Hydraulics & Machinery Inc. . . . **Elmer J. Mlinar** named works manager for the main Stanford, Conn., plant of Consolidated Diesel Electric Corp. . . . **Donald E Dufford** appointed head of applications engineering at Genesys Corp. . . . **Charles Peterson** named chief engineer of Veet Industries . . . **W. E. Rowe** elected vice president—manufacturing of Long Mfg. Div., Borg-Warner Corp. . . . **James R. Brown Jr.** appointed director of manufacturing at Dresser Industries Inc. . . . **Dr. George A. Downsbrough** elected president of the Scientific Apparatus Makers Association . . . **Edward O. Falberg** appointed division manufacturing manager of Bohn Aluminum & Brass Corp. . . . **Howard D. Hartough** elected president of the Chemical Products Div., Chemetron Corp. . . . **Jay W. Schnackel** appointed vice president of Remington Rand Div., Sperry Rand Corp. . . . **J. E. Williams** appointed corporate vice president for manufacturing services at Olin Mathieson Chemical Corp. . . . **A. C. DeAngelis** elected vice

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Interested in Saving Real Money on Trichlorethylene?

DETREX Customers Save Thousands of Dollars Per Year

Although solvent degreasing is a most economical method of metal cleaning, operational studies often result in trichlorethylene savings of 15%.

Any trichlorethylene degreasing operation which has not been studied recently by an experienced degreasing engineer is a logical candidate for this 15% saving—*or even more.*

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Write for your free copy of Dr. C. E. Kircher's informative paper: "Solvent Degreasing—What Every User Should Know."

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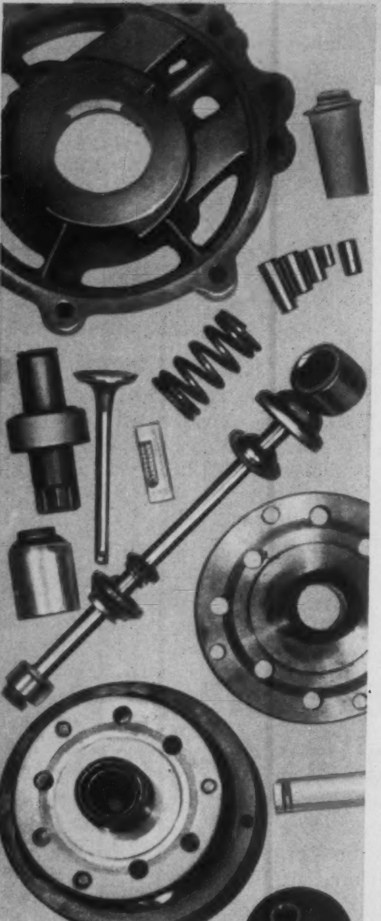
World's Largest Exclusive Producer of Cleaning Chemicals and Equipment

Circle 666 on Page 17

..... practical automation ideas



Portable Demand-Feed Storage

For plants operating on a job-run basis, Gear-O-Mation has recently developed a number of portable storage units which can be quickly rolled into position at various machines to provide demand feed. One such unit has storage 'containers' for several sizes of parts. An important advantage: parts are protected against damage in handling into and out of storage and at the machine.

Simple Locating Shuttle

A simple walking beam device permits the quick shuttling of large castings from one machine or line to another, locating the part in the second machine automatically in the same motion.

Gear-O-Mation Division was organized in 1956 to develop and build highly practical automation equipment GEARED TO EITHER EXISTING OR NEW PROCESSES AND MACHINES—whether already in use or new.

Automated Handling of Fragile Parts

Fragile parts can be handled between operations without danger of injury by a conveyor with removable pallets. The pallets carry the work to the proper place and then return to the starting point on a separate conveyor. A typical use: manufacture of grinding wheels.

No Electrical Units

A combination parts-accumulator, storage device and demand feeder has no electrical connections or devices. Servicing of parts elevators, escape mechanisms, sensing devices, etc., can be be done with a couple of wrenches and a screwdriver. All controls and operating units are pneumatic.

It is the policy of Gear-O-Mation to use only proven mechanical, pneumatic, hydraulic or electrical devices in its automation equipment. This minimizes chances of service interruptions and insures minimum cost consistent with reliability and performance.

"Wash Just Before Use"

Demand-feed storage units can be combined with integral parts washers in such a way that parts can be cleaned as they go into storage or just before they come out, or both. Best practice seems to be: clean parts shortly before they pass on to the next operation.

The success of Gear-O-Mation's "simplicity" policy is attested to by the successful operation of Gear-O-Mation equipment in a wide variety of industries and both continuous or job-lot types of plants.

Irregular Parts Can Roll Too

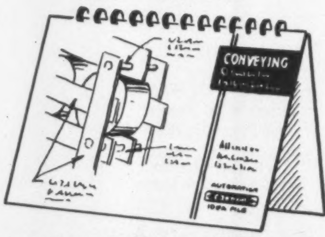
Parts that are notched and have a tendency to interlock can be fed by gravity without difficulty provided the proper chute angle is used. At Gear-O-Mation we don't depend on 'paper calculations' for this. 'Adjustable angle' gravity test chutes are used to find the best chute angle to avoid interlocking and yet feed parts at minimum rolling speed to avoid damage.

To automate you do not need to spend fortunes. Nor do you have to go in for complex electrical or electronic control. Frequently the simplest solution is the best. That's Gear-O-Mation's philosophy. Yes, we know, it often takes more ingenuity to do things simply rather than by complex devices. But that's our stock in trade—INGENUITY.

Cleaning-Up Boosts Output

Experience shows that where handling of parts is automated, the increased plant cleanliness alone tends to boost production more than would be expected from the automation alone. Some plants get increased output simply by "getting everything off the floor".

NEW "IDEA FILE"



Every Gear-O-Mation field engineer now carries with him an "Automation Idea File." It contains sketches and details of practical answers to many parts handling problems—orienting, feeding, positioning, conveying, distributing, etc. These ideas will suggest variations to suit your exact needs. Have a Gear-O-Mation field engineer go through the "Idea File" with you soon! Use the handy coupon at left.

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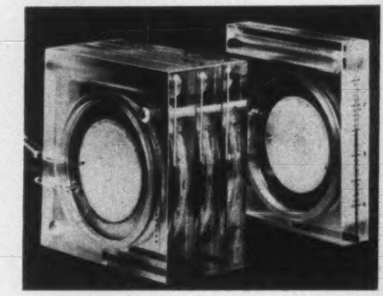
GEAR-O-MATION
Division of Michigan Tool Company
7171 E. McNichols Rd., Detroit 12, Mich.

Yes! I want to see the time- and money-saving ideas in your new "Idea File." Have your field engineer show it to me soon!

Name____________________
Company____________________
Street____________________
City____________________

Circle 667 on Page 17

president of Dynamics Corp. of America . . . **George D. Rice** named vice president—manufacturing at Humphrey Inc. . . . **Walter Lipkin** appointed vice president of operations at North Atlantic Industries Inc. . . . **Marvin B. Lorig** appointed vice president and general manager of Panellit Service Corp. . . . **J. Kenneth Koster** named manager of production and engineering at the Calvert City, Ky., plant of B. F. Goodrich Chemical Co.



PROTOTYPE models of a new type of voltage meter have been built by the Mullenbach Div., Electric Machinery Mfg. Co., using electrostrictive ceramic discs as the dynamic moving element. Each meter consists of a transparent block enclosing two metal discs on which smaller discs of white ceramic have been bonded. Each ceramic wafer is coated on both sides with silver frit, forming a capacitor. When an electric potential is applied, the ceramic wafers contract, cupping the metal discs. Colored fluid between the metal discs is forced to rise in a capillary tube at the front of the meter, providing a visual indication of the applied voltage. Each meter measures less than 0.75 inch in width, allowing a number of units to be mounted in the space normally required for a conventional voltage meter.

SPOTLIGHTING PLANTS

CompuDyne Corp. is the new name for CDC Control Services Inc., manufacturer of dynamic control systems for process industries. . . . **Van Norman Industries Inc.** has acquired working control of American Pulley Co. in which it has held a minority interest for three years. . . . **Hunt Valve Co.** has started construction on a 12,000 sq ft office building in Salem, Ohio. . . . **IMC Magnetics Corp.** is the new name of Induction Motors Corp., manufacturer of electronic and electromechanical components. The corporation has also recently acquired Mason Electric Corp., manufacturer of heavy duty rotary switches, and Gray & Kuhn Inc., makers of time-delay lines and

ACTUAL SIZE
NEW

WESTINGHOUSE HEAVY-DUTY PROXIMITY LIMIT SWITCH

- WON'T WEAR OUT . . . completely static, never needs to be replaced
- WATERPROOF . . . operates completely submerged in liquid
- EXPLOSION-PROOF . . . new Westinghouse switch is "potted" . . . all internal connections are completely sealed
- CUTS INSTALLATION TIME . . . trip point is easily adjusted by balance adjusting screw . . . no contact or lever arm adjustment
- CORROSION RESISTANT . . . impervious to salt spray
- DESIGNED FOR MILITARY APPLICATIONS . . . has passed military shock and vibration tests
- TWO SENSING HEADS AVAILABLE . . . for either tripping distances within ½ inch . . . or within 2 inches

Why not get all the facts about the new Westinghouse heavy-duty proximity limit switch . . . see how and where it can save you time and money and give you a better job. Contact your nearby Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, Director Systems Department, 356 Collins Avenue, Pittsburgh 6, Pennsylvania. J-01017

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PAR

the TRS Process that employs standard and multi-head machines to make riveting practically a new fastening method!

PAR . . . Production Automated Riveting

Perfected for over 3 years . . . proved successful in some of industry's most efficient plants . . . the TRS PAR Process opens the way to new economies for 7 out of 10 assemblers of metal products.

Through TRS Production Automated Riveting, costly manual handling of parts on the machine and between machines may be much reduced. Operations may be performed in multiple, simultaneously. Rate of fastening may be speeded up to an unheard-of point. Machine down-time and rejects cut to a negligible amount.

Automation of Assembly Operations becomes a reality through efficiently integrated and automatic . . .

1. FEEDING of tubular rivets or related products.
2. TRANSFER of parts to — or between — riveter stations.
3. SEQUENCING from 3 to 15 rivet setters to operate simultaneously or in any desired order.
4. CONTROL of setting force as required by parts thickness or material characteristics.
5. SENSING of improper conditions and stopping equipment to avoid injury to parts, equipment, or operator.
6. EJECTION of parts as required.

WHY only TRS Can Offer the PAR Process . . .

Obviously, there are two vital elements in the PAR process. Essential is the special knowledge and experience acquired by TRS engineers through the design, tooling and application of many Multi-Head Riveters for complicated production requirements. TRS originated Multi-Head Riveters over three years ago and is the only experienced source of these machines. Equally important, and partly resulting from this unique TRS experience, is superior knowledge of how to design an efficient system of riveters, feeders, transfers and controls . . . whether with standard riveting machines or Multi-Head Riveters

TRS

TUBULAR RIVET & STUD COMPANY
Quincy 70, Mass.

TRS SALES OFFICES: Atlanta • Buffalo • Charlotte • Chicago • Cleveland
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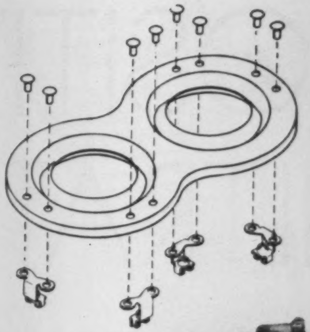
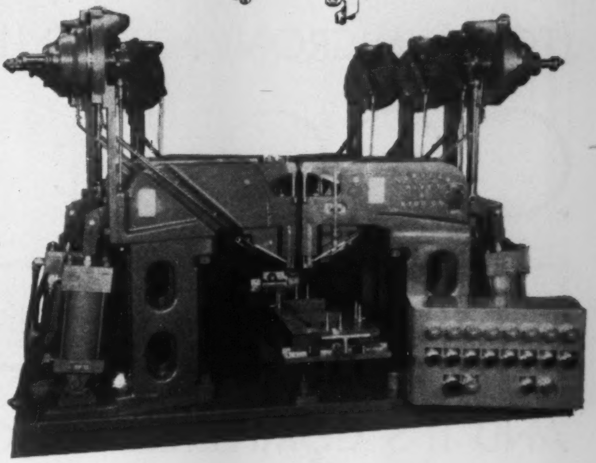
WAREHOUSE IN CHICAGO See "Yellow Pages" for phone numbers

ELECTRIC AUTO-LITE

attaches 4 brackets at a time with push-button speed

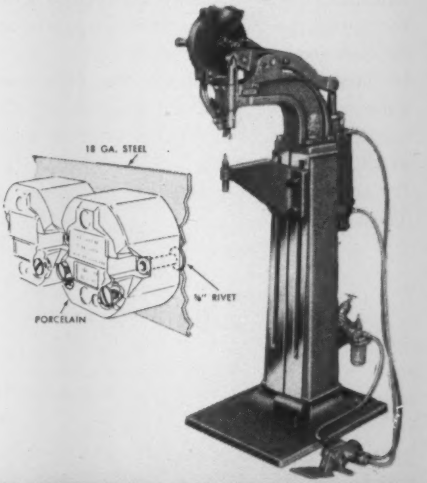


Dual headlight frames required the attachment of four angle brackets with eight rivets. Electric Auto-Lite invited TRS engineers to help develop a way to do it at high speed, with a minimum of manual handling. The solution is shown here . . . an ingeniously engineered TRS multi-head riveting set-up of eight independent air-powered machines working on very close centers, and a sliding loading fixture containing eight anvils. The operator need only load the frame and brackets, slide the loaded fixture into riveting position and press a button. All eight rivets are set simultaneously. A hold-down attachment on the loading fixture keeps the workpiece in position until released by the operator. A push-button panel permits independent cycling of any one or any combination of riveters if desired. An important feature of the set-up is in the relative simplicity of rearranging the machines as needed to accommodate a future change in parts design.



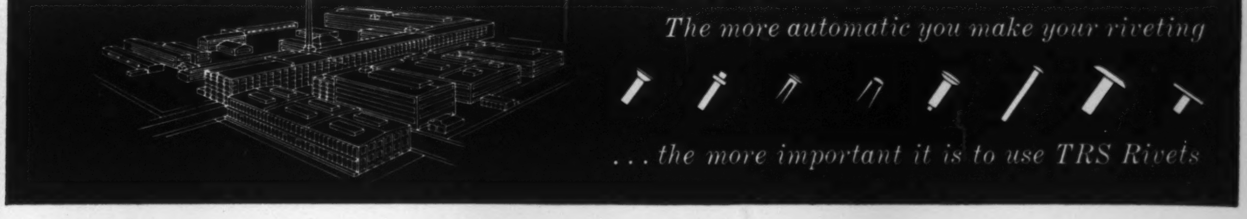
. . . and LIBERTY ELECTRIC *rivets porcelain switches with a standard machine, 1/6 of the labor, and no breakage*

Nut-and-bolt assembly of porcelain-base switches on an electric stove was slow, used relatively expensive fasteners. Automatic riveting would be far faster and cheaper — but how to avoid breaking the switches under the force of the setting? The TRS man had the answer: an air-powered long-stroke modification of a standard TRS riveter, adjustable for "cushioned" setting of the right size of cad-plated semi-tubular rivets. Results: Savings of ⅚ of the labor, savings in fastener cost per unit, higher uniformity of product, and no breakage.



ASK to see more Case Studies . . .

. . . if your product can be riveted, and especially if several rivets are involved, phone or write that you want to see the detailed exhibit of the way many plants, large and small, use the TRS PAR Process.


The more automatic you make your riveting
. . . the more important it is to use TRS Rivets

POSITIVE FILTRATION

(TO 1/2 MICRON) FOR AS LITTLE AS

.00015¢ PER GALLON!

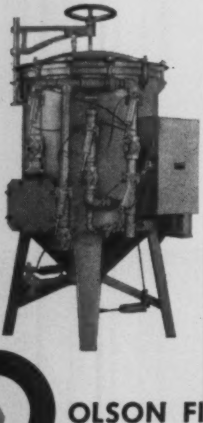
AND IT'S COMPLETELY AUTOMATIC!

Now, from Olson, a new dimension in industrial filtration — the first completely automatic, pressure-type filter! Every cycle — precoat, run, backwash—is automatically controlled. Injection of filter-aid (when used) and sludge carry-out are also automatic.

Maintenance is virtually eliminated in this trouble-free system. No parts to change, no elements to replace, and most important, *no costly downtime for cleaning!*

In large central systems, or with individual machines, Olson Filters guarantee over 96% purification of all types of coolants, cutting oils, quenching oils, cleaning and washing solutions and other industrial solvents at the lowest cost per gallon.

By the way, what are *your* costs per gallon? Why not check and see? Then call Olson.



The new Olson Industrial Filter is available in 8 standard models, from 10 gpm to 600 gpm capacities.

Write for free catalog on the new Olson automatic pressure-type filter.

OLSON FILTRATION ENGINEERS
Division of The American Laundry Machinery Company
DEPT. A, CINCINNATI 12, OHIO

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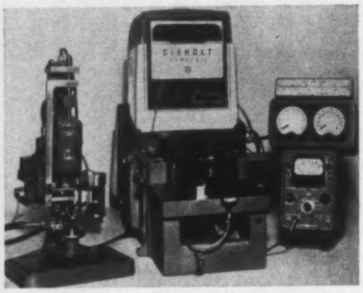
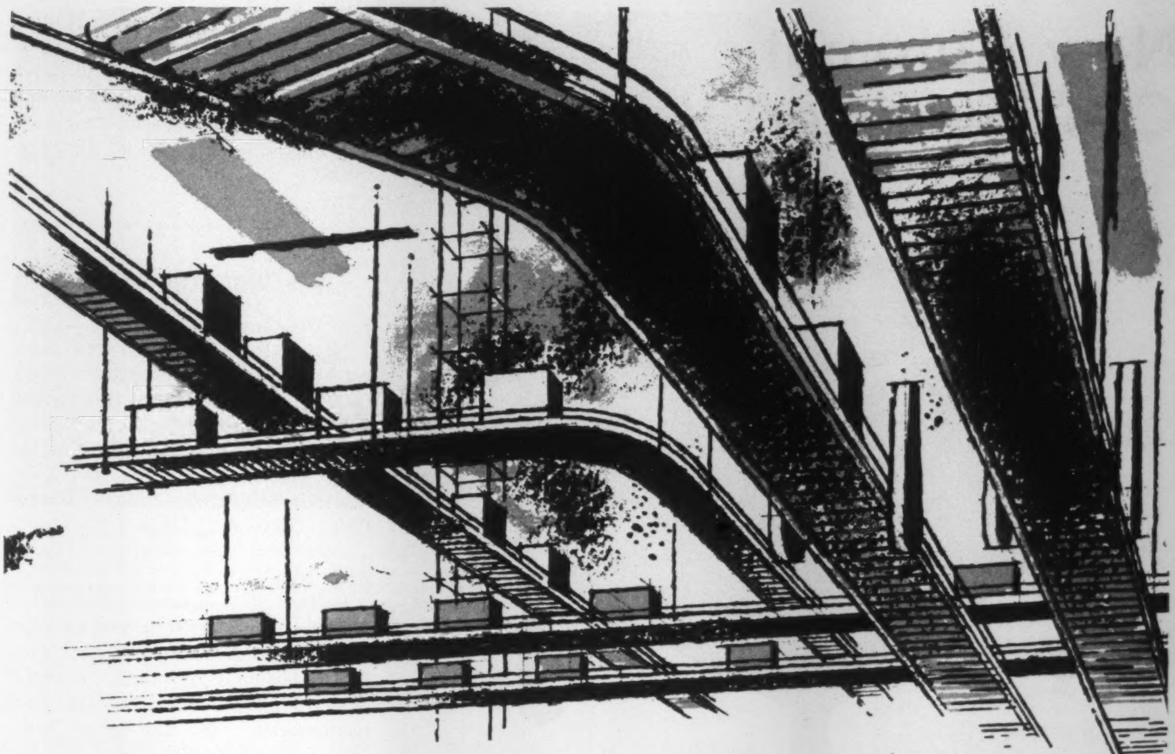
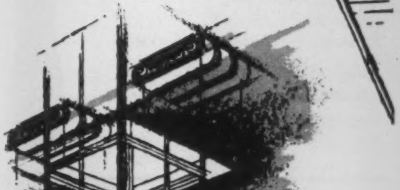


HIGH SPEED bench-type balancers have been introduced by Gisholt Machine Co. to handle miniature belt-driven, air-driven, or electrically self-driven parts and assemblies. Unbalances causing work support movements greater than 0.000002 inch with the work rotating at any speed between 1000 and 3000 rpm or between 4000 and 12,000 rpm can be accurately measured and located. Optional photo-electric cell, below missile gyro work-piece, measures angle of unbalance in relation to a single reference line on the rotor. Meters at right indicate unbalance amount and angle. Tachometer below meters indicates rotational speed. Corrections on workpiece are made on the drill press at the left.

pulse forming networks. . . . **American Machine & Foundry Co.** has organized a Tobacco Products group and an Electrical Products group to strengthen its position in these two fields. The Tobacco Products group consists of the AMF Tobacco Div. and the International Cigar Machinery Co. Forming the Electrical Products group are Potter & Brumfield Inc., Leland Electric Motor Div., Leland Aircraft Products Div., and Leland Electric Canada Ltd. . . . **Streeter-Amet Co.** has purchased Bell Electro Way Systems from Bell Aircraft Corp. The purchase includes all drawings, patent applications, work-in-process, raw materials, and finished parts for the electronic continuous weighing system. . . . **Computer Systems Inc.** is the new name for Mid-Century Instrumatic Corp. . . . **Hupp Corp.** has purchased the valve operator division of Cutler-Hammer Inc. and will receive all tools, fixtures, and inventory. Manufacturing operations will be moved to the Chicago plant of Hupp Aviation Co. which will be responsible for servicing Cutler-Hammer valve operators now in use. . . . **Autonetics**, a division of North American Aviation Inc. has started construction of a new 162,000 sq ft manufacturing building in Downey, Calif. . . . **Chicago Pneumatic Tool Co.** has acquired by cash purchase the assets of Reich





increased output from present plant...

ANOTHER REASON WHY INDUSTRY MOVES
BETTER ON ALVEY-ENGINEERED CONVEYOR SYSTEMS

Increasing **floor** space doesn't always increase **flow** space . . . or output. Your handling problems may be better solved through a completely fresh approach. "Live" storage, reduced manhandling, improved pacing, faster, smoother intake of materials and outgo of products . . . whatever it may be, Alvey engineers take in the whole problem . . . create a comprehensive solution.

Within your industry, chances are good that conveyor systems engineered by Alvey have increased output . . . cut production costs, often 30% and more. Get together with Alvey engineers in the **pre-planning** stage. Write or call

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Circle 671 on Page 17

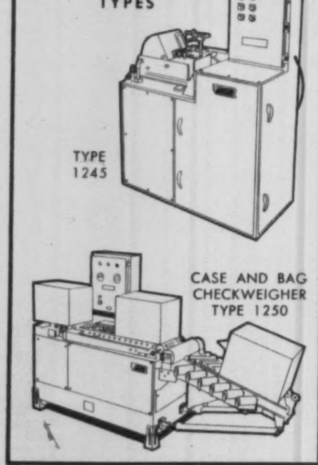
New Automatic Checkweigher

Signal lights and counters for control and adjustment of filling or processing machines are available as optional equipment.

SELECTROL®

TYPE 1206

OTHER SELECTROL TYPES



TYPE 1245

CASE AND BAG CHECKWEIGHER TYPE 1250

This new Selectrol Checkweigher sorts either closed or open packages and permits trimming of rejects. Operating speeds up to 120 weighings per minute; accuracies of 2/10 of one percent of the product weight. Greater speeds are possible at lower accuracies . . . and greater accuracies at lower speeds. Operation is completely automatic. Tolerances are adjustable.

Selectrols are made by Exact Weight, a manufacturer of scales for 45 years, with experience gained through hundreds of checkweighing installations during the past 18 years in 28 states and in foreign countries.

Write for Bulletin 3377.

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BETTER QUALITY CONTROL . . . BETTER COST CONTROL

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Bros. Mfg. Co. Inc. of Terre Haute, Ind., and the Reichdrill Mfg. Co. Ltd. of Glasgow, Scotland. . . . **Tomkins-Johnson Co.** has moved into newly-completed manufacturing and office facilities at Jackson, Mich.

MEETINGS AND EVENTS

July 29—Aug. 1—

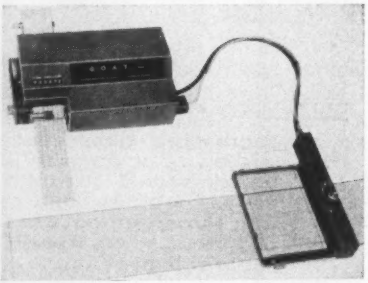
National Tool & Die Manufacturers Association. Summer board meeting to be held at the Grand Hotel, Mackinac Island, Mich. Additional information is available from George S. Eaton, NTDMA headquarters, 907 Public Square Bldg., Cleveland, Ohio.

Aug. 10-13—

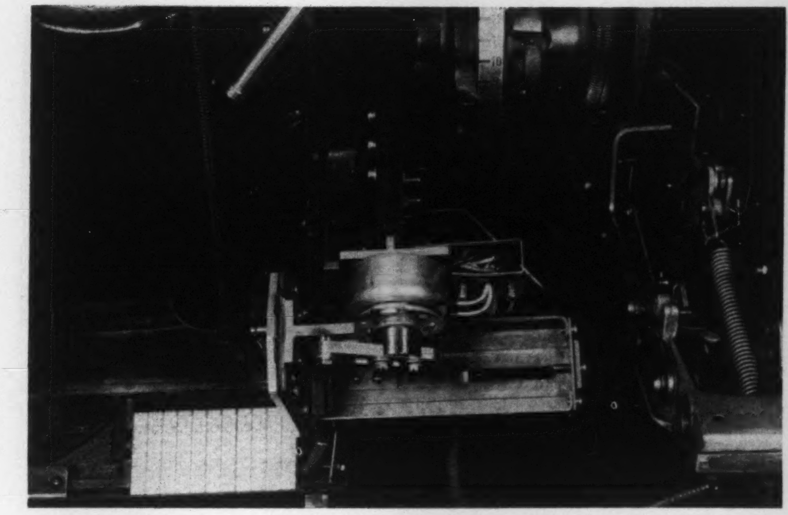
Society of Automotive Engineers. National west coast meeting to be held at Hotel Georgia, Vancouver, B.C. Additional information is available from John A. C. Warner, SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Aug. 19-22—

American Institute of Electrical Engineers. Summer general meeting to be held in Sacramento, Calif. For further information, contact N. S. Hibshman, AIEE headquar-



DATA REDUCTION instrument offered by Gerber Scientific Instrument Co. reads oscillogram and strip chart amplitudes up to 6½ inches and prints these data on an adding machine tape. Reading head, with a driven paper transport, has a variable hairline that can be moved along a Y-axis in either direction by means of a control knob. The head is connected to the printer through a flexible shaft and electrical control cables. The printer prints out a 2-digit sequential count or time index and a 4-digit amplitude value. The reading head also incorporates a variable scale along the X-axis which divides timing lines or timing peaks so that any desired number of readings can be made between these two reference points.



HORIZONTAL rule dropper developed by Fairchild Graphic Equipment Inc. automatically inserts either steel or lead rules between classified ads as type is being set. The device is attached to a linecasting machine directly above and slightly to the right of the outside galley, and can be operated either manually or by perforated tape. After each classified ad has been cast into slugs and delivered to the galley, a signal in perforated tape or a manual switch causes the ad separating rule to automatically drop into the galley behind the last line of type. The unit can be used with either steel or lead rules having a thickness of 2 to 4 points and a length of 9 to 12 picas.

ters, 33 W. 39th St., New York 18, N. Y.

Sept. 1-3—
Association for Computing Machinery. Fourteenth national conference to be held at Massachusetts Institute of Technology, Cambridge, Mass. Additional information is available from Dr. Frank M. Verzuh, Computation Center, MIT, Cambridge, Mass.

Sept. 13-17—
Pressed Metal Institute. Annual meeting to be held at the Stanley Hotel, Estes Park, Colo. Additional information is available from Harold A. Daschner, PMI headquarters, 3673 Lee Rd., Cleveland 20, Ohio.

Sept. 16-17—
Business Forms Institute. Fall meeting to be held at the Greenbrier Hotel, White Sulphur Springs, W. Va. For further information, contact Alden E. Calkins, BFI headquarters, 350 Fifth Ave., New York 1, N. Y.

Sept. 17-18—
American Society of Mechanical Engineers. Engineering management conference to be held at the Statler-Hilton Hotel, Los Angeles, Calif. Additional information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

Sept. 21-22—
Standards Engineering Society. Eighth annual meeting to be held at the Somerset Hotel, Boston, Mass. For further information, contact Charles T. Ajamian, P. O. Box 538, Wayland, Mass.

Sept. 21-25—
Instrument Society of America. 14th annual Instrument-Automation Conference to be held at the International Amphitheatre, Chicago. Additional information is available from ISA headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

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AUTOMATION
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"We had to automate, but we still managed to keep the personal touch in our product."

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YODER
PIPE AND TUBE MILLS

Today's expanding markets and tightening economy demand closer production cost control. YODER'S complete line of ferrous or non-ferrous Pipe and Tube mills can help you meet production schedules economically... help you realize significant savings in the manufacture of tube and pipe.

YODER Pipe and Tube mills offer flexible production to meet fluctuating demand. They adapt easily to the most rigorous schedules. Everyday manufacture of constant high quality pipe and tube in diameter of 5/16" to 24". Speeds up to 350 fpm plus can be obtained with YODER mills.

YODER also makes a complete line of Slitting equipment and Cold Roll-Forming machinery. Send for your copy of the fully-descriptive book covering Tube Mill operation.

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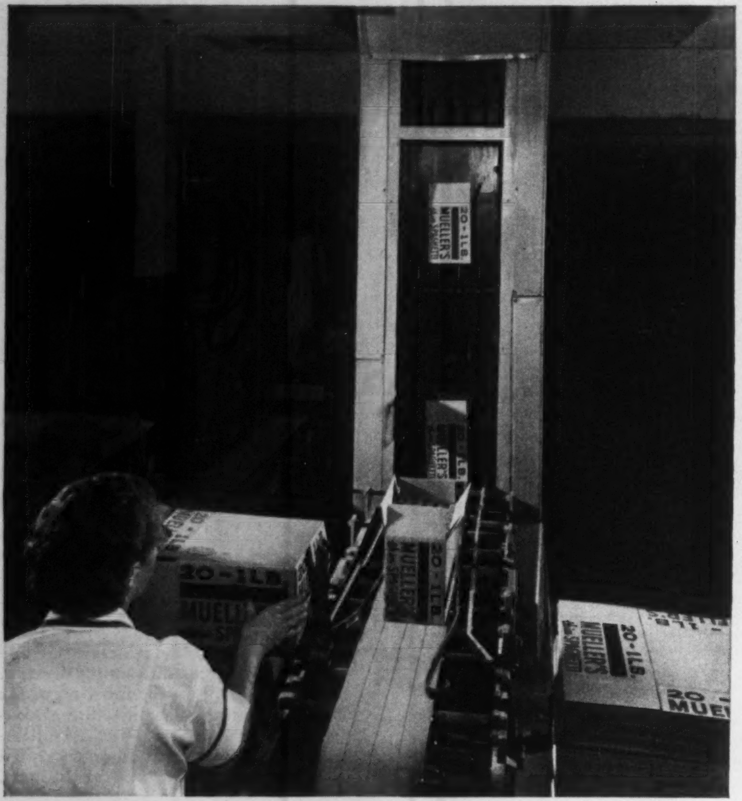
HEAVY DUTY UNCOILERS

TUBE MILLS

ENGINEERING YODER MANUFACTURING
PIPE AND TUBE MILLS
(ferrous or non-ferrous)

Circle 673 on Page 17



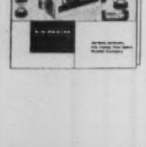
Space-Saving Tray Elevator Boosts Mueller Production!

Because this Robo-Lift Tray Elevator ascends straight up, C. F. Mueller Co., Jersey City, increased production without costly remodeling. To cope with stepped-up consumer demand, the nation's largest macaroni manufacturer rearranged and increased the capacity of its product weighing, packaging, cartoning and sealing operations. To hike the output, engineers placed the automatic sealing unit high above floor level. However, due to cramped quarters, a vertical elevator was needed to carry product-filled cartons to the sealer.

Only the Lynch Robo-Lift Tray Elevator met all requirements and specifications.

Space-saving and jam-proof, the automatic upright operates a sixteen-hour shift, handling cartons at the prescribed rate of six-per-minute. Featuring unique infeed and discharge systems, the elevator cannot jam —ever. And, unlike bar and belt-type models, it doesn't mar or rub a carton's printed message. Through fixed positioning of trays, pendulum action is eliminated and cartons ride safe, secure, easy.

Robo-Lift Tray Elevators are available for a variety of lifting or *lowering* assignments. For full details on how Tray Elevators serve, request free literature, today.



Write for illustrated booklet which details the complete story titled, "LYNCH Robo-Lift Tray Elevator . . . moves cartons vertically, saves time, money, floor space at C. F. Mueller Company."

Lynch Corporation—*Manufacturing Engineers of automatic processing equipment for the glass, packaging, plastic and other industries.*

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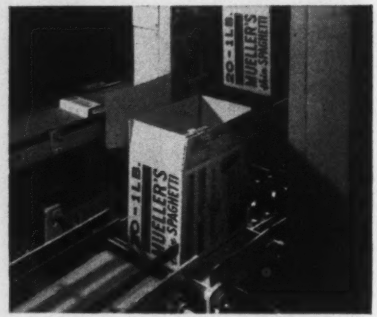
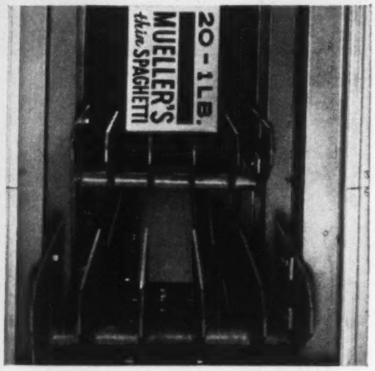
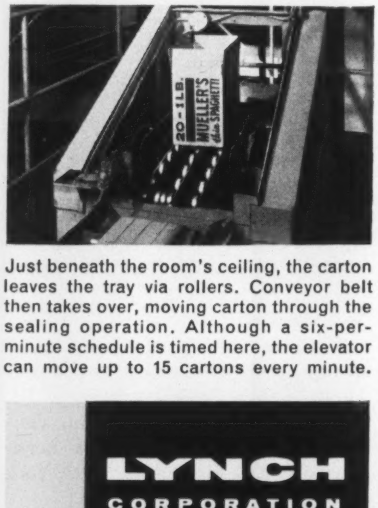


Close-up shows a filled carton beginning its gentle Tray Elevator ride upward. In the foreground, the next carton in line has moved off conveyor belt and is automatically held back until oncoming tray appears.



Moving straight up, the carton rests on a fixed, non-pendulum tray that neither swings nor sways . . . always holds carton steady, secure. Note how carton's open end bottom is held in a closed position until it reaches the sealing unit.



Just beneath the room's ceiling, the carton leaves the tray via rollers. Conveyor belt then takes over, moving carton through the sealing operation. Although a six-per-minute schedule is timed here, the elevator can move up to 15 cartons every minute.

LYNCH
CORPORATION
Anderson, Indiana

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detroit dateline

By JAMES C. KEEBLER Managing Editor

Data processing system at Chevrolet's national parts distribution center in Flint, Mich. automatically processes production, warehousing, and distribution data.

Multiples of Millions

BRIGHT-EYED and enthusiastically the little six year old Becky had observed the neighborhood's commotion and reported authoritatively to her father that "It looks like this is the year to buy a car."

In eleven words this youthful observer had candidly reported on one of the most puzzling situations in modern marketing. Motivation researchers of all calibers have been studiously trying to tell us why the buyers leave or enter the market in droves. Certainly a lot of people would like to know.

Big Second Half

Yet, even though neither of them really knows why, Becky's observations very closely match those of Chrysler's president, L. L. Colbert, who told the 43rd Annual Meeting of the National Industrial Conference Board that the industry would sell about 6 million cars at retail this year. Recognizing that crystal ball gazing is never very dependable, he hedged that many things could make his estimate too low or too high. Despite the uncertainty of the future, there is a confidence gained by observations of the past, "In our industry we have never experienced a year in which a retail market as good as the one we are having in the first half was followed by a poor market in the second half."

Automaters take heart from the assurance that the second half will bring in the money. When there's dough in the till, the man with his hand on the tiller is in a better position to let loose of some of a most essential ingredient of an automation program—money.

Score Keeping

Keeping track of the ups and downs of this industry is a mighty complex job especially for those who plan production quantities and schedule the flow of material and parts through the arteries of the supply lines. Most of us common people can keep track of several hundreds of things—recognize several thousand words—might live to eat 100,000 meals, but find quantities in the millions to be outside the category of our experiences and beyond the realm of our comprehension.

Multiply 6 million cars by 8 spark plugs, 5 tires, 30 some bearings and you are soon into the mutiples of millions that stagger the mental powers of even the more sophisticated mathematical minds.

Small wonder the industry has been actively procuring large-scale data processing systems to keep score of the status quo and the direction in which it is zigging.

Over the Road

The American automobile scene is characterized by problems of mentally incomprehensible complexities of combinations of big numbers. Louis Lundstrom, director of GM Proving Grounds, reminded the SAE last month that the industry needs to take a "new objective look" at both vehicle and road designs. To be objective one must look at the big picture. Lundstrom noted that the National Highway Bill, ". . . is either directly or indirectly concerned with every road system and all classes of vehicles."

With all due respect for the magnitude of the need, the size of the problem is staggering to the imagination. To be conservative consider that 65 million registered vehicles averaging 10 thousand miles a year travel a whopping 650 billion miles annually.

Consider the New York Thruway alone. 1957 traffic on the 538 mile road included 47½ million individual trips. The morning after the 4th of July weekend last year 518,000 toll cards were received for processing at Thruway Headquarters. There are only 48 toll stations, and 10 classes of vehicle toll, but the management discovered that this makes 16,020 different fares possible when all combinations are considered. They keep account of: 1. Traffic breakdown by vehicle class at each toll station. 2. Tabulation of point-to-point trips. 3. Volume of traffic passing each interchange. 4. Monthly billings of charge accounts to 325 trucking firms. 5. Total number of trips by vehicle class. 6. Total mileage by vehicle class.

To handle this formidable chore the Thruway abandoned the original plan of division office accounting staffs in New York, Albany, Syracuse, and Buffalo and established a centralized operation that uses a Remington-Rand Univac File-Computer system.

This system processes punched cards at the rate of 27,000 per hour and can withdraw magnetically stored data in just 7 milliseconds. Even at that rate it has a hard time keeping up with Thruway traffic volume.

Visualization Problem

In an effort to state in general terms the basic problem of manipulating multiples of millions it appears that in most cases these are made up of manageable units or fractions of units which can be readily visualized individually or in small groups, but when viewed in the aggregate it becomes difficult to see the relationships of the subgroups to the whole or the effects that changes of a subgroup may have upon any other subgroup.

This is further complicated by the simplicity in visualizing a useful purpose for different breakdowns of the aggregate data into more types of analyses, and the complexity of achieving such breakdowns when the aggregate equals multiples of millions.

If a turnpike gasoline station lessee complains, unjustly, that the volume of traffic passing his establishment is dwindling, it may be a useful thing to have a handy Traffic Density Report refute the complaint and suggest he look to other areas such as the possibility of upgrading his service. Electronic data processing systems readily provide such breakdowns that would be monumental chores it attempted by manual clerical methods.

A true objective analysis goes beyond one thruway system where the original data is relatively easy to obtain, and covers a comprehensive study of the entire transportation system including interstate, primary, secondary, and urban road systems. Shooting the moon sounds simpler.

Manufacturing Data

A "new objective look" at the manufacturing systems of motor vehicle production is as complex a problem as that of the nation's transportation system.

Data processing systems that include some pretty big computers are working on the automakers' problems. Chrysler processes engineering and production releases through a central computer-equipped group able to handle 30.5 million characters in an eight-hour day.

Joseph Mitchell (left), administrative supervisor of machine accounting for the New York State Thruway Authority, discusses the day's work with Joaquim DeCristo, Remington Rand technician who keeps the Thruway's Univac File-Computer in good working order.

Ford's M-E-L central office computer facility analyzes and summarizes sales orders into 731 schedule codes that Mercury adopted to describe all of the various assembly combinations of parts, accessory options, and trim. Four computer programs provide the basis for Mercury's manufacturing scheduling for four assembly plants. These provide: 1. Daily production schedules for a five-day order backlog. 2. Next month's detailed production schedule. 3. Six month's forward plan by plant, body mix, options, accessories and trim. 4. Bimonthly revision of parts commitments and shipment releases for vendors.

In order to give manufacturing people a look at the melon any way they want to slice it, a fifth computer program is being set up to control in-plant parts inventories.

To produce, warehouse and distribute 50,000 listed replacement and accessory part names, Chevrolet relys on the help of a data processing system designed around an IBM 705 computer. Manual handling of inventory records is a thing of the past, the centralized record library handles over 250,000 transactions daily.

These systems are examples of a trend to centralized data processing operations that link many subgroup functions of the business and provide vital breakdowns of data that would be almost impossible to obtain otherwise.

Each step in incorporating more data from more sources is a step closer to integrated control of manufacturing operations all the way from the customer's yen to buy to the shovel in the Mesabi Range. Each creates a new combination of factors that accumulates to a point beyond the individual's ability to mentally master, but can be presented to him in usable form.

Automation Challenge

The desire to capitalize on economically useful systems of this sort presents a big challenge to automaters. It is easy to suggest areas of application, but implementing those ideas takes keen insight.

Possibly the biggest advantage is the ability to correlate individual analyses and make them meaningful against the background of the big picture. Rather than be lost in a morass of details, the manufacturing engineer sees hope that he may be master of the details of production, no matter how complex the product becomes.

Common language data systems will eventually be hooked onto numerically controlled production systems and the whole operation functions more effectively. One of the biggest hurdles in the way of this accomplishment is the inability of individuals to grasp the big picture and see all the details at once. Data processing installations have a way of lifting themselves by their bootstraps and pulling us over this hurdle.

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TO FINISH

Precision boring and facing

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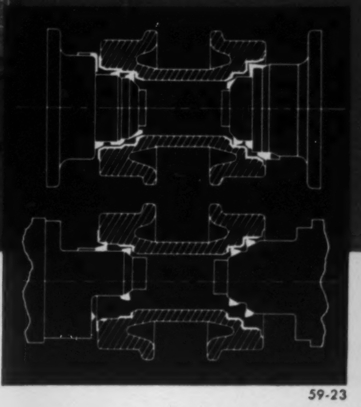

59-23

Ex-Cell-O Custom Machine—with quick-change tooling—speeds output of large, cast-iron track rollers

This Ex-Cell-O Custom Machine features precision—in a big way.

A track roller for rugged, off-the-road equipment, is clamped in the hydraulically-actuated fixture; the rest—from rough to finish—is automatic.

The part is first rough-bored on both ends at the same time. Then both slides retract and the fixture indexes into position for finish boring and facing at both ends, simultaneously. (Drawing, above-right, shows rough and finish tooling.) Slides again retract and the fixture is unclamped, ready for the next cycle. Easily changed tooling heads and clamping jaws permit precision machining of any of three similar components with minimum lag in production.

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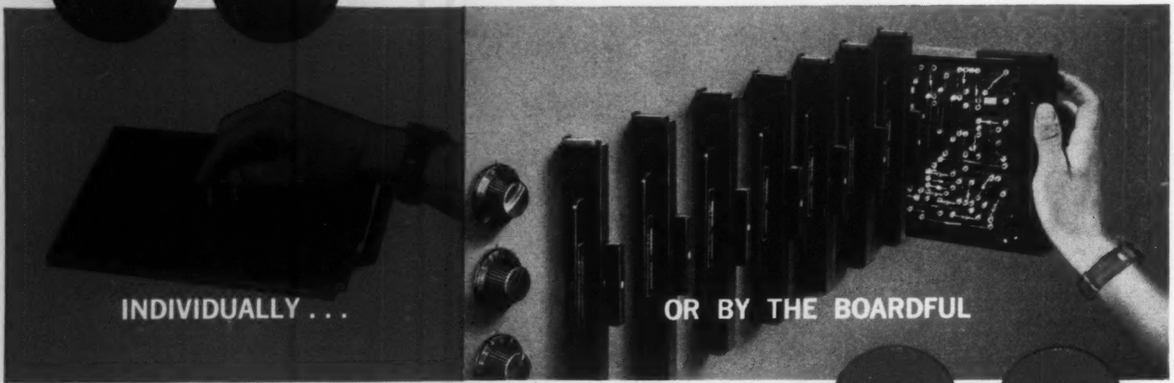
“INSTANT COMPONENTS...”



For the first time, here is a component programming device in which the number of inter-chassis connection points is directly related to the chassis area. Without wrenches, soldering irons, or other equipment—you can instantly replace your mounted components, singly or by the hundreds with AMP's all new "816" Pluggable Chassis. These units can be stacked like books on a shelf to save you space and weight and you save also on the number of units and intercircuit connections you use compared to other techniques.

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western trends

By **PATT PATTERSON**
Los Angeles, Calif.

Van-size containers are used by Matson Navigation Co. to speed delivery of seaborne freight. Used as deck loads, the cargo containers are loaded and unloaded by a shoreside gantry crane under control of one operator without the help of signalmen. Rundel Electric Co. made the equipment which controls the hoist, trolley travel, and gantry travel. Indicators on the console enable the operator to know the position of the load at all times and the locations on the ship deck where a load can be placed. The gantry crane was built by Pacific Coast Engineering Co.

Generally Speaking

LONG boosted by its active chambers of commerce as the industrial center of the West, California is also well known in agricultural circles as being a major producer of farm products. Los Angeles County, for example, is one of the largest dairy areas in the world.

The pattern of California farming is increasingly one of large-scale farming. And because of this larger scale, automation is an increasingly potent force in the agricultural picture.

Farm machinery manufacturers have been talking of the "farm revolution" for years, and in California their salesmen are actually participating in the vanguard of the movement toward automation. In some areas produce is picked, transported to the packing shed and sorted, processed and packed—all automatically. The story, while impressive, is not universal. Automation of farming is barely in its infancy, but daily more and more food producers are looking toward automatic equipment as the answer to lower costs and greater output.

It is the question of greater output which has halted many eager farmers on their way to buy automatic equipment. When he and his fellows produce too much, the prices drop, and their work becomes the means to their own bankruptcy. It is this problem that the farmers of the West consider carefully in their selection of automatic equipment for the farm.

Dry Run Programming

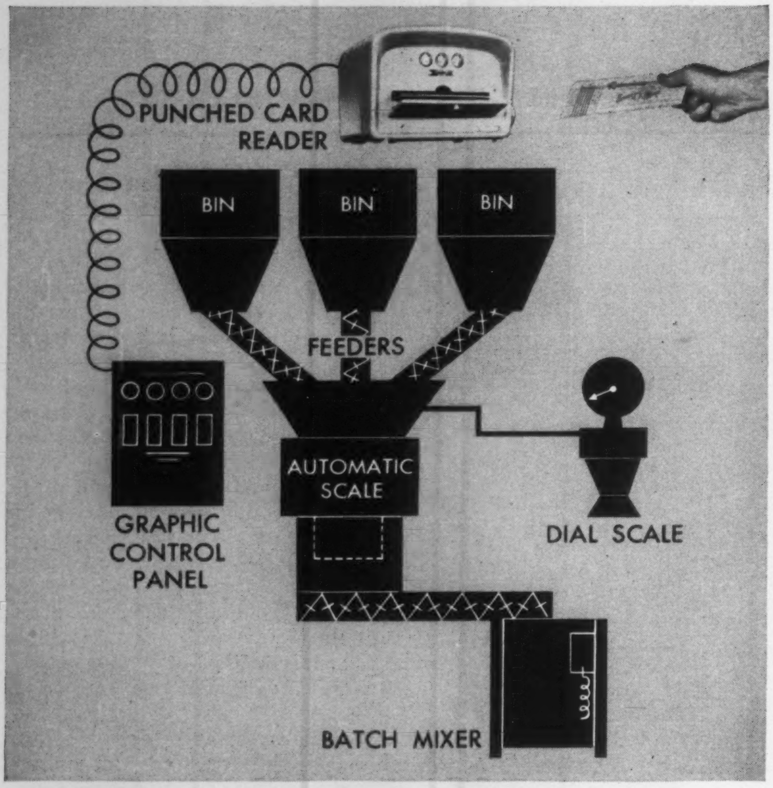
Solar Aircraft has reduced both time and rejection rates by installing vertical turret lathes equipped with automatic recorders and control mechanisms. The Bullard machines must be setup by operators working from instruction sheets prepared by production engineering. The operation is run through without the part, setting speeds and feeds on the automatic memory recorder. After a complete recording is made, the castings or other parts may be loaded, and the entire cycle is then run through automatically. The major advantage Solar has found is that the operator has a chance to monitor the speeds and feed rates of the machine in preparing the recording. This permits more direct control than when the machine is actually programmed by the production engineering department. The operator may program for specific metal characteristics, or for operating peculiarities of the machine which he is operating.

Automatic Checkout

Before one of the giant missiles can be launched with any reasonable degree of certainty of operation, it must be checked through all of its operating phases to be certain that the thousands of parts are each performing their functions.

With a highly complex network of electrical and mechanical devices, some manual countdowns go on for as long as 8 hours, and by the time one section is checked out, the previous one may have developed a malfunction. For a battle-ready missile, a manual system of checking is impractical.

The answer, of course, has been the development of automatic checkout equipment, which will run the missile through its paces on the ground. This is accomplished by programming the checkout equipment with an operational sequence that stops short of actual launching. Usually provided on punched



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AUTOMATES

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The Richardson Select-O-Weigh system governs all components required for automatic formulation by weight of any product, liquid or solid, involving any number of ingredients.

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1556

Circle 677 on Page 17

paper tape, such a program may even have launching instructions, for use when checking out a missile for that final death-dealing blow against an enemy.

With the complexity of the modern aircraft, one possibility of the future is that the airplane, too, will be checked out thoroughly by an automatic unit prior to take-off.

Ore Processing

Near Grants, N. M., a new uranium mill is an example of how a process can be almost completely automated with conventional, standard instruments. Uranium processing at the Homstake Sapin Partners mill has automatic centralized control of the majority of the processing stages.

Crushing, sampling, grinding and classification, thickening and digestion, thickening and filtration, steam generation and recarbonation, and the precipitation-drying-packaging stages are all completely automated, with centralized controls. Areas in which the most complex operations take place, however, have as many automatic controls as possible, but centralized control was not felt to be practical at this time.

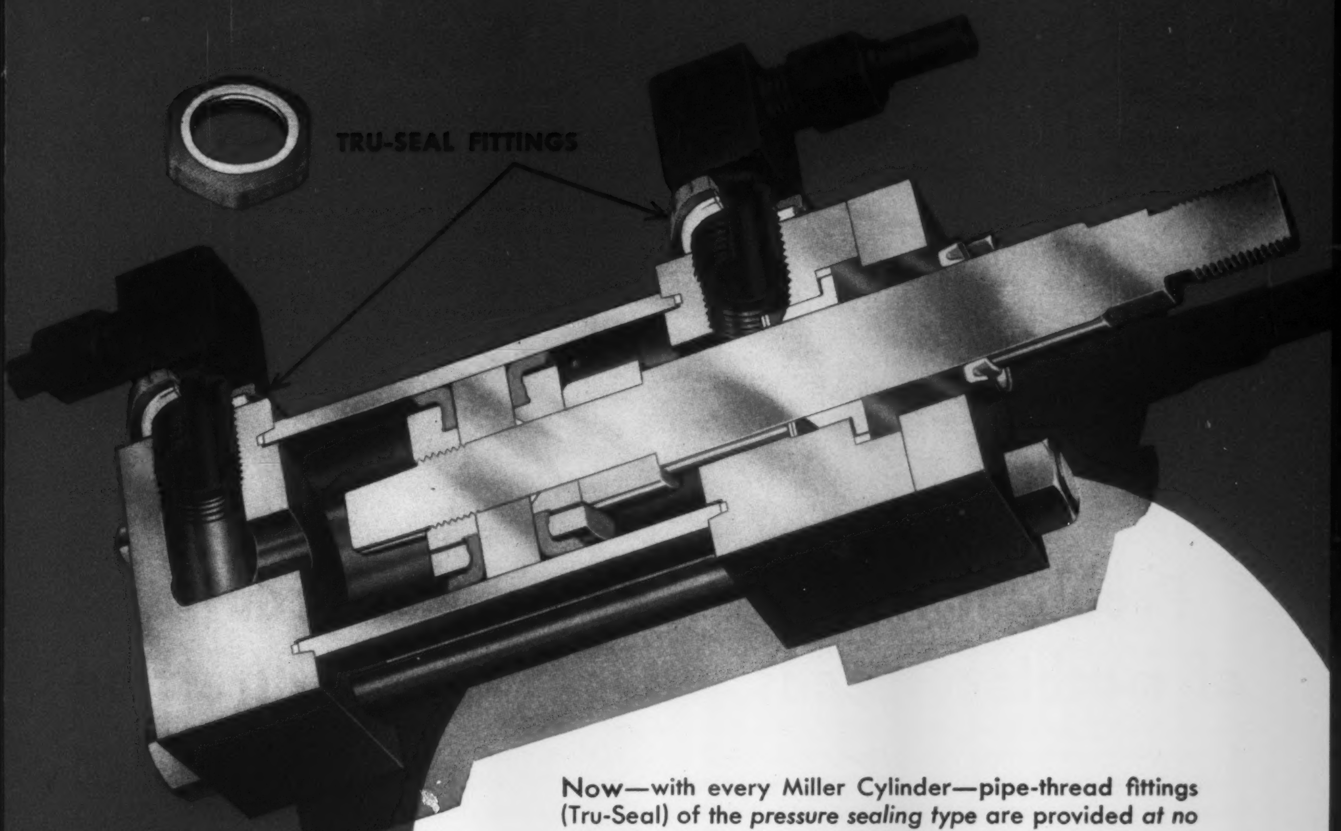
After the uranium ore (which is found in an 85 per cent silicon dioxide sandstone) is crushed and screened, it is fed into supply bins. From there, automatic controls feed the various ores to a ball mill by weight. The blended and ground ore is classified in a mill solution, which is also automatically controlled.

Thickeners, where density is adjusted before the slurry is fed to the digesters, are supervised by automatic torque controls, which sound a warning when the load on the mixing drive reaches a certain point. These controls will cut off the drive completely if the load goes above a preset danger point. The density is controlled by controllers which sense changes in the slurry concentration and add diluting solution when required to keep the density at a proper level.

Because of the complete, centralized control of the seven major stages of processing, the entire 1,500-ton-per-day plant is operated by one supervisor and nine operators, a record for this type of plant.

NOW... even the PORTS have seals of the PRESSURE SEALING TYPE!

(J.I.C. Standard H6.2.2)



Now—with every Miller Cylinder—pipe-thread fittings (Tru-Seal) of the *pressure sealing type* are provided *at no extra cost* for sealing the cylinder ports.

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2. Damage to equipment caused by high tightening torque is completely eliminated (especially on valves, pumps, etc.)
3. Sealing material is Teflon, which is compatible with all hydraulic fluids (J. I. C. Standard H6.2.1)

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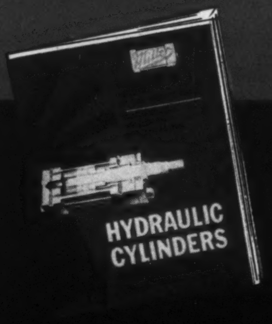

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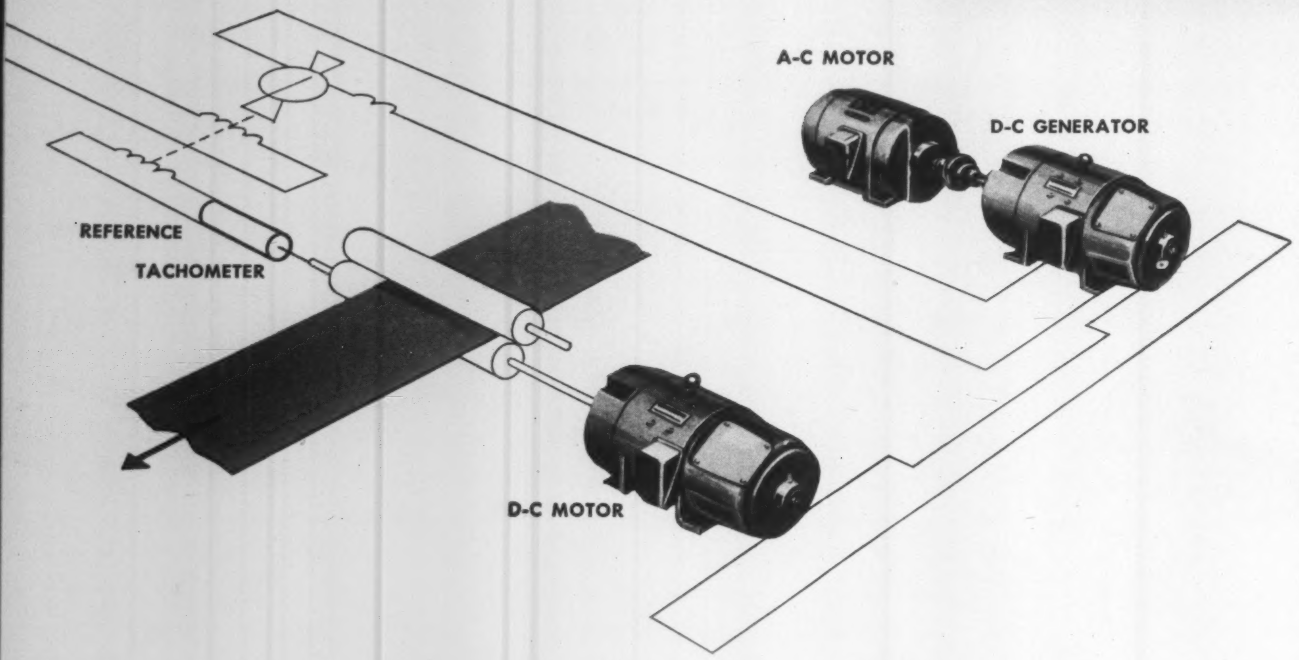
D-C DRIVES FOR PRECISE CONTROL



Problem: How to obtain precise control of machine speeds without human direction

Automation's most important requirement—*self-control*—enables machines to process work continuously with minimum human effort. This is why the trend to continuous automatic processing is a trend to direct-current drives. ***For d-c can best supply the precise regulation and self-control that enables a machine to correct its own errors without human direction.***

Feedback—the heart of automation—compares machine output with pre-established standards. Deviations are corrected automatically, instantaneously. This is just one example of d-c's modern capabilities.

If you are seeking more automatic, lower cost means of production, it will pay you to investigate direct-current drives. A new booklet, "WHY D-C?", written for modern industry's management team, is available to help you. For your free copy, write *Section 829-4, General Electric Company, Schenectady 5, New York.*

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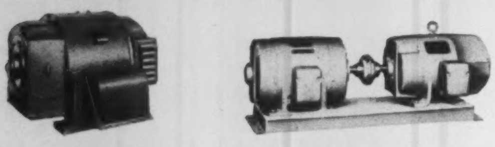
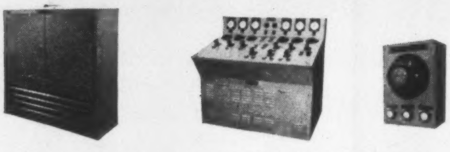


MOTORS AND GENERATORS



POWER UNITS AND CONTROLS

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AUTOMATION

JULY 1959

Capitalized Labor

With the continuing growth of automation during the past decade, there has been evident a progressive change in the character of working conditions. Although there is great concern over possible ill effects, all too little is said about the advantages brought about by introduction of automation in manufacturing industries.

Most significant among the advantages apparent is the rapid rise in professional, technician, and white collar jobs in these industries. Not to be overlooked, also, is the fact that automation is gradually invalidating the still too common practice of using labor as a commodity to match output with market demand.

Of concern to all of us is the direction in which industry is heading regarding labor. In all honesty, no really accurate and satisfactory answer can as yet be outlined in detail. Nevertheless, a general idea of expected changes can be gleaned as management gradually adjusts to evolutionary changes taking place. At the recent Southern Conference of the Controllers Institute of America, Dwayne Orton, educational consultant of IBM, presented one such interesting glimpse into the future with this statement:

"The older labor conditions of large supply and high rates of payroll to sales will change, and the problems of industrial relations will alter quantitative to qualitative. Labor expense will shift to labor investment. Labor will be capitalized rather than expensed. Volume of labor will be replaced by quality of labor. The concept of labor as the flexible element to adjust to the business cycle will shift to the concept of labor as the element to be preserved. New forms of incentives for all levels of personnel will develop."

Change is inherent in the American scene. Along with technical changes wrought by automation will come a continuously improving working climate and a rising degree of industrial stewardship dedicated to the general welfare. Just how soon we will reach this new enlightened level of capitalized labor depends on vision and understanding leadership in both industry and labor circles.

EDITOR

AUTOMATION

Proper climate must be established to make the techniques of manufacturing engineering effective. Projects must be determined with consideration of underlying general areas for improvement which can be identified by use of various management tools. Each project can then be completed as a coordinated effort under the manufacturing engineer from investigation of processes and vendors to equipment acceptance.

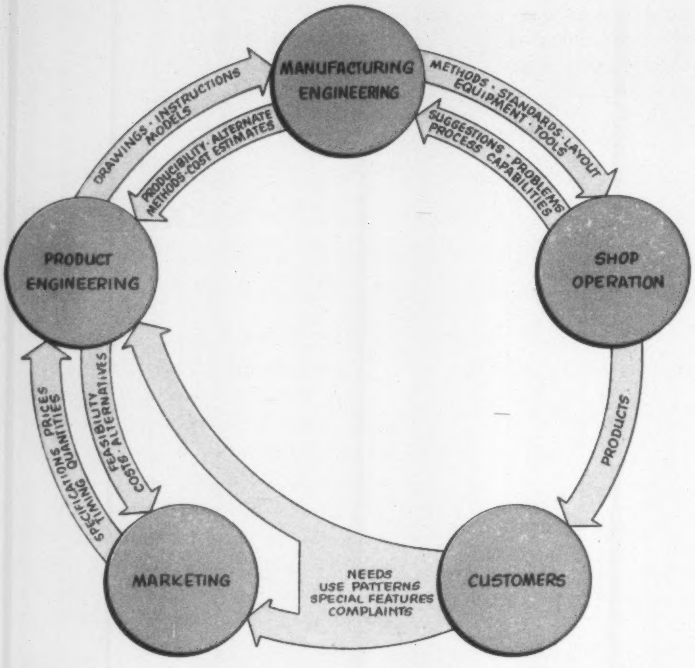
MANUFACTURING ENGINEERING
METHODS · STANDARDS · LAYOUT
EQUIPMENT · TOOLS
SUGGESTIONS · PROBLEMS
PROCESS CAPABILITIES
SHOP OPERATION
PRODUCTS
CUSTOMERS
NEEDS
USE PATTERNS
SPECIAL FEATURES
COMPLAINTS
MARKETING
SPECIFICATIONS PRICES
TIMING QUANTITIES
FEASIBILITY
COSTS · ALTERNATIVES
PRODUCT ENGINEERING
DRAWINGS · INSTRUCTIONS
MODELS
PRODUCIBILITY · ALTERNATE
METHODS · COST ESTIMATES

Fig. 1—Representation of product cycle shows that Manufacturing Engineering is an integrated part of the total business. Manufacturing Engineers must play an active role in determining product design with the emphasis on producibility.

MANUFACTURING ENGINEERING AND MACHINE PROCUREMENT

By **ARMIN C. FRANK Jr.**, Manager—Manufacturing, Vacuum Cleaner Dept., General Electric Co., Cleveland, Ohio

WITHIN THE SPAN of a single generation the nature of the manufacturing function of a business has been radically changed. Just a few short years ago Manufacturing was that activity which was responsible only for finding some way to make what Engineering designed. Since Engineering itself was relatively unsophisticated, the average manufacturing operation was able to get by with a shop full of belt-driven, general purpose machine tools. But three significant trends have presented a challenge to Manufacturing. First, there has been the geometric increase in consumer demand for more and better goods of all types. Second, there has been the explosive progress of research and engineering. Third, there has been a significant increase in highly effective competition.

These three things have forced Manufacturing to run as fast as it can just to keep up. Our business economy is based on profits, and costs and profits go hand in hand. In the long run, to have profit leadership it is necessary to have cost leadership; to get cost leadership we in Manufacturing

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This article is based on a paper presented at the "Third Conference on Manufacturing Automation" cosponsored by AUTOMATION and Purdue University, March 1959.

have had to change our way of life. As compared with ten years ago, General Electric Co. Manufacturing today is new in concept, new in organization, new in technical and mechanical know-how, and largely new in methods and machines. We are new in technical and mechanical know-how as a result of establishing the Manufacturing Engineering subfunction; and we are largely new in methods and machines because our Manufacturing Engineers have found ways to make our products at lowest possible cost.

▶ The Manufacturing Engineering Function

Just what does General Electric mean by Manufacturing Engineering? Many companies use the terms "Industrial Engineering" or "Production Engineering" to describe similar work. We adopted the term "Manufacturing Engineering" to differentiate between what we used to call Wage Rate and Planning and our new concept of vastly increased technical scope. First of all the term describes a kind of subfunctional manufacturing work. The work of Manufacturing Engineering is to determine the equipment, processes, tools, layout, methods, time standards, and facilities required to produce products when needed, in scheduled quantities, to specified quality levels, at lowest possible cost. The key words are *at lowest possible cost* because they immediately place upon Manufacturing Engineering the responsibility for being active rather than passive in the entire business organization.

The passive role is the old concept of finding some way of making the products designed by the Product Engineering function; of looking at today's problems today instead of having looked at them yesterday, so that today is reserved for looking at the problems of tomorrow. The active role is the new concept where Manufacturing Engineering is an integrated portion of total business work. For instance, *Fig.* 1 shows the role of Manufacturing Engineering in the over-all work of product design. Here, Manufacturing Engineering plays an active part in actually determining product design with the emphasis on producibility. The Product Engineer is basically responsible for determining functional design which will meet the requirements of customers as translated by Marketing.

With today's complete technology the Product Engineer has a full time job keeping up with the progress in his own function; he no longer can be an expert also in the latest manufacturing techniques. Since product design largely determines the *how* of manufacture, and therefore the cost, the Manufacturing Engineer must see that producibility is designed into the product before it is released from the drawing board. Similar integrated relationships can be shown in the development of long range facilities plans where the Manufacturing Engineer must develop a high degree of teamwork with the Marketing functions responsible for sales forecasts and product planning and with the Product Engineering function responsible for future changes in basic design. These and other integrated relationships are required if Manufacturing Engineering is to achieve the lowest possible cost.

In looking at Manufacturing Engineering work in detail, General Electric found that it consisted of two basic kinds. "One involves work directly related to current production commitments. It is aimed at achieving or bettering planned cost by maintenance and improvement of existing tools, methods, and standards to avoid breakdowns, wasted effort, and extra costs. The other is directed toward long-range projects consisting of major cost reductions, new processes and techniques permitting lower costs and product design innovations, and the furnishing of specialized knowledge to insure designs that are easily manufactured."[1] Organizing for these kinds of "manufacturing engineering work

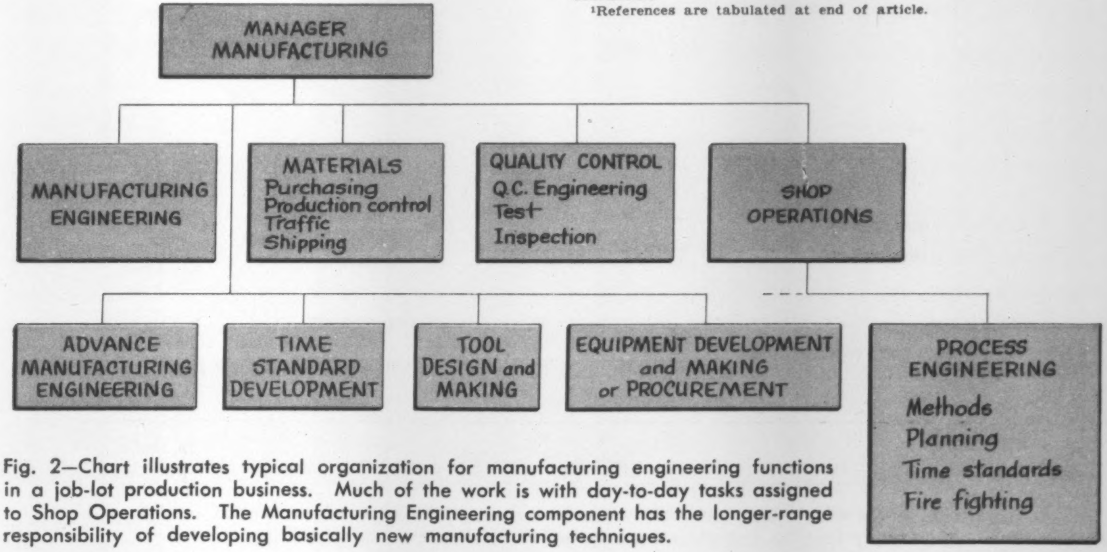

Fig. 2—Chart illustrates typical organization for manufacturing engineering functions in a job-lot production business. Much of the work is with day-to-day tasks assigned to Shop Operations. The Manufacturing Engineering component has the longer-range responsibility of developing basically new manufacturing techniques.

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[1] References are tabulated at end of article.

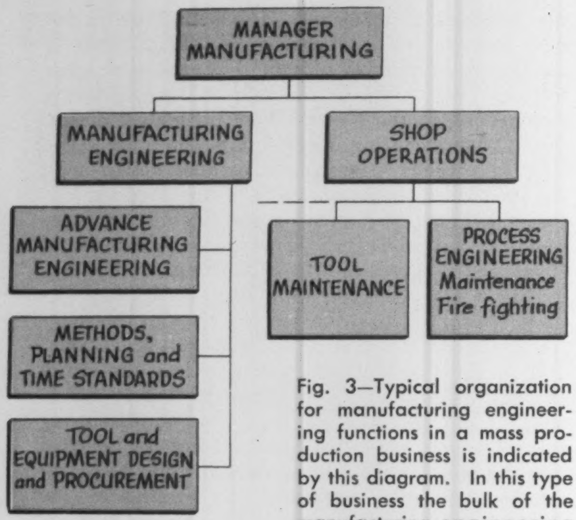

MANAGER MANUFACTURING
MANUFACTURING ENGINEERING
SHOP OPERATIONS
ADVANCE MANUFACTURING ENGINEERING
METHODS, PLANNING and TIME STANDARDS
TOOL and EQUIPMENT DESIGN and PROCUREMENT
TOOL MAINTENANCE
PROCESS ENGINEERING Maintenance Fire fighting

Fig. 3—Typical organization for manufacturing engineering functions in a mass production business is indicated by this diagram. In this type of business the bulk of the manufacturing engineering work is of the long-range variety which is assigned to the Manufacturing Engineering element.

requires bringing together a diversity of skills, training, and experience to apply to problems ranging from selection of machine tools valued at hundreds of thousands of dollars to establishing temporary methods for reworking small lots of off-standard material."[2]

Manufacturing Engineering can further, ". . . be classified into the following basic subfunctions which, together, account for all the work defined as manufacturing engineering and are necessary to discharge the several responsibilities of the manufacturing engineering function."[3]

Advance Manufacturing Engineering. As suggested by the word "advance," the work of this subfunction is essentially long range in nature. It includes the establishment of long range manufacturing plans and requirements for new or expanded facilities; the determination of feasibility and the development of new manufacturing equipment, tools, and processes. Much of this work is self-initiated and is directed toward major make-versus-buy and automation projects. Other work is externally initiated by the broader requirements of the over-all business plan and concerns preparation for new products, model changes, or design changes for which existing facilities are not adequate.

Process Engineering. Work "in this function is concerned with determining the operation sequence, equipment, and tooling to be used for current production orders. This kind of planning involves existing equipment, tooling, and established time standard data. Work is short-range in nature and does not usually require or justify extended study. Much of the sporadic, unpredictable, and frequently urgent 'fire-fighting' work is a part of this function. Such work includes correction of minor tooling or methods difficulties and planning rework or extra-work operations. The majority of the work is externally initiated by the requirements of the production schedule and the need of shop operations for specific technical information."[4]

Methods and Time Standards. Work of this function "is to determine the motions necessary to do

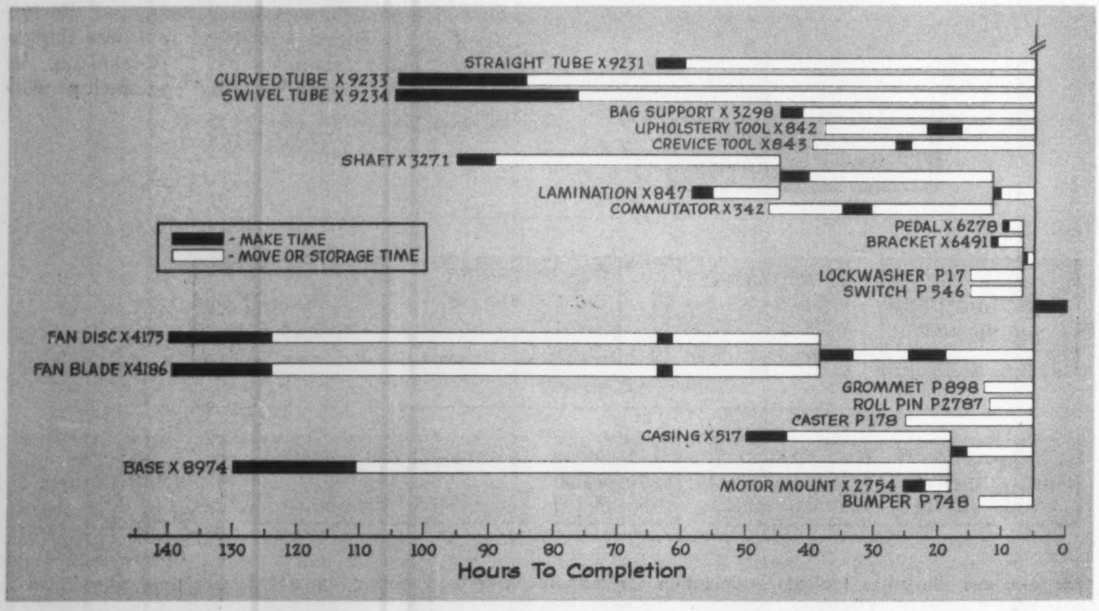


Fig. 4—Manufacturing cycle chart represents one of the tools which can be used to identify underlying general areas in which to improve manufacturing operations.

work, the time required to do it, the workplace layout, and the instructions needed to achieve the most effective human effort. Activities are both short and long range. Long range work includes the development and preparation of basic time standards data and the study, recommendation, and adaptation of wage payment plans. Short range work covers detailed analysis of individual operations, methods development, and determination of specific time standards."[5]

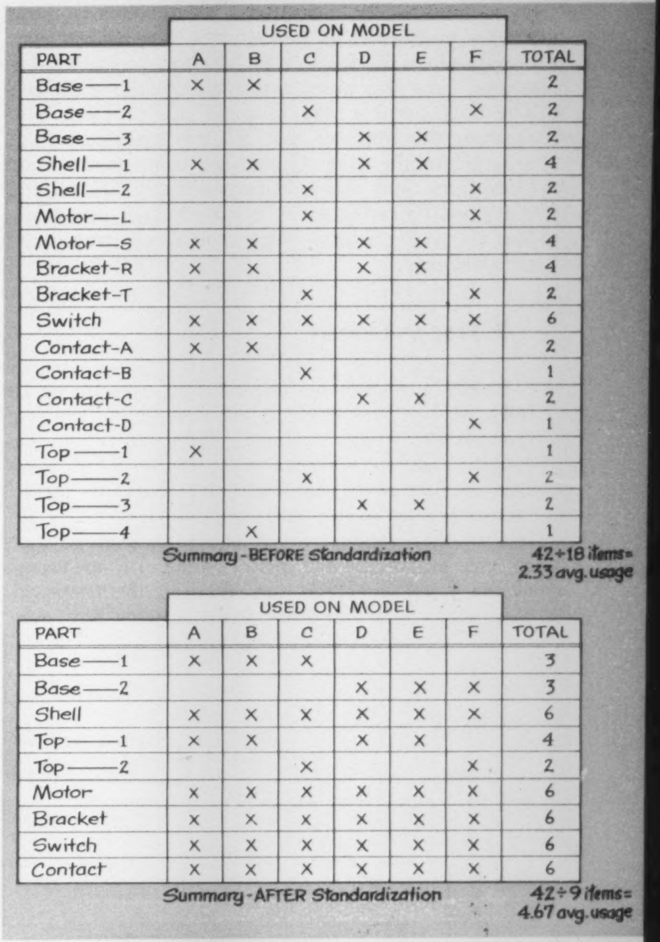
Equipment and Tool Design. The work of this function is to reduce the developments of Advance Manufacturing Engineering to drawings and specifications for equipment, tools, dies, jigs, and fixtures. Most of the work requires high technical proficiency and is long range in nature.

Equipment and Tool Making and Maintenance. The work of this function is to make those tools, dies, jigs, fixtures, and equipment not purchased outside and to maintain such equipment so that it will be available when required by shop operations.

▶ Effective Organization

After the specialized functional work described above has been detailed into various work elements in each category, its actual assignment to components and individual positions in the organization will depend upon the balanced weighing of all the current criteria for organization structuring. It is not my purpose to dwell upon this aspect other than to point out those specific criteria which are of most concern to the organization of manufacturing engineering work. It must be remembered that a description and definition of specific work elements and relation of these elements in functional groupings in no way implies that these work elements must all be assigned to a specific organization component or individual position. A distinction must be made between the work and its assignment in the organization. It is the magnitude and complexity of work that should be the basis of organization. A study of manufacturing engineering work in a significant number of General Electric decentralized business operations developed no uniform organization pattern that could be isolated based on a single factor such as size of the business, product complexity, or length of product line. However, it was found that differences do exist between plants having the primary characteristics of job shop manufacture as opposed to mass production.

In the job shop, *Fig.* 2, there are frequent changes in setup and few units of identical design are produced consecutively. "Much of the manufacturing engineering work consists of day-to-day operation planning, establishing time standards, and routine determination of methods and tooling. This work is usually assigned to Shop Operations, with the Manufacturing Engineering component assigned the longer range responsibility of developing basically new manufacturing techniques and working with Product Engineering on producibility of fundamentally new designs or materials."[6]



	USED ON MODEL						
PART	A	B	C	D	E	F	TOTAL
Base——1	×	×					2
Base——2			×			×	2
Base——3				×	×		2
Shell——1	×	×		×	×		4
Shell——2			×			×	2
Motor—L			×			×	2
Motor—S	×	×		×	×		4
Bracket-R	×	×		×	×		4
Bracket-T			×			×	2
Switch	×	×	×	×	×	×	6
Contact-A	×	×					2
Contact-B			×				1
Contact-C				×	×		2
Contact-D						×	1
Top——1	×						1
Top——2			×			×	2
Top——3				×	×		2
Top——4		×					1

Summary - BEFORE Standardization

42+18 items=
2.33 avg. usage

	USED ON MODEL						
PART	A	B	C	D	E	F	TOTAL
Base——1	×	×	×				3
Base——2				×	×	×	3
Shell	×	×	×	×	×	×	6
Top——1	×	×		×	×		4
Top——2			×			×	2
Motor	×	×	×	×	×	×	6
Bracket	×	×	×	×	×	×	6
Switch	×	×	×	×	×	×	6
Contact	×	×	×	×	×	×	6

Summary - AFTER Standardization

42÷9 items=
4.67 avg. usage

Fig. 5—Collation charts are also useful in outlining general projects. They are helpful in standardization studies as indicated by this "before and after" summary of six different models[7] in which components were standardized.

In mass production, *Fig.* 3, the primary emphasis is on the period of time an operation may run without change. Methods, time standards, tooling and equipment requirements are determined and proved well in advance of scheduled production. Subsequent followup is devoted mainly to minor troubleshooting, rebalancing for schedule changes, and keeping the lines running. Most of the manufacturing engineering work is long range and organized in the Manufacturing Engineering component. The short-range, fire-fighting work is frequently assigned to Shop Operations.

In analyzing the two basic organization patterns it becomes apparent that the significant organizing principle is the separation of short and long-range responsibilities. It has been proved time and time again in all types of situations that there is an inevitable tendency for immediate problems to crowd out and delay achievement of long-range projects. A man tends to work on those things upon which he is most easily measured, and there is nothing so easy to measure as a production line being down. Conversely it is difficult to measure progress on a two or three year manufacturing engineering project. The only sensible way to avoid this problem is to separate the work so that all fire-fighting work is assigned to the Shop Operations component. Shop Operations thus has sole responsibility for keeping the plant operating at or below planned cost while Manufacturing Engineering has *only* long-range work responsibility.

▶ Proper Climate

Proper attention to organization structuring is only one of the keys to effective manufacturing engineering. Proper climate and motivation are equally essential. Climate refers to the entire business environment and attitude in which manufacturing engineering must operate; motivation refers to those things which cause an average man to give above-average performance. In one sense of the word climate is the result of the teamwork generated in a business organization. But even more it is that intangible something "esprit de corps." Whatever its full sense it can hardly start lower than the top and be effective because Manufacturing Engineering is dependent on the other subfunction of Manufacturing and on the functions of Marketing, Product Engineering, and Employee Relations.

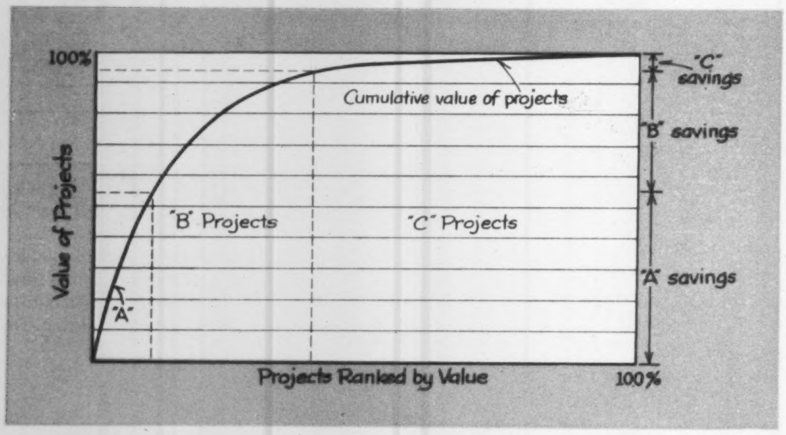


Fig. 6—Curve of cumulative value of projects plotted against number of projects[8] usually shows that a few projects represent a large portion of the potential value. Optimum results from manufacturing engineers' efforts can be obtained by identifying such projects and selecting a program that promises the most return with due consideration of probability of success, time to complete, and other factors.

At any level, barriers to proper climate can be deadly. For instance, producibility can only be the result of teamwork between an individual product engineer and an individual manufacturing engineer who have a common goal and want to attain it. A typical barrier to producibility is "professional jealousy." This professionalism manifests itself in arguments as to *who* is right rather than *what* is right. It breeds rivalry rather than respect; it feeds on ego and getting credit; it makes engineers reluctant to work on ideas not conceived by an engineer; it makes engineers resent constructive criticism regarding the producibility of their designs. The situation can become even worse when compounded by Marketing. Many producibility decisions mean product redesigns which affect Marketing. While Marketing must have a voice, it must not be subjective in demanding more and more features at less and less cost. Marketing must accept its joint responsibility with Product Engineering and Manufacturing Engineering for cost reduction, planned cost, and profitability.

Another barrier to effective manufacturing engineering climate concerns the relationships between Manufacturing Engineering, Shop Operations, and Employee Relations. There is nothing more devastating to the morale of a manufacturing engineer than failure to gain the desired result from a methods or equipment project because the new production quota or piece rate is not acceptable to the operator and the union. Too often this situation results from failure to build understanding of the proposed change by the Shop Operations and Employee Relations personnel because they, in turn, do not have full understanding of the nature of the change and the need for it. Nothing short of complete teamwork in this area can be successful in achieving effective manufacturing engineering.

▶ Individual Motivation

While climate mostly concerns the area *around* manufacturing engineering, motivation concerns the area *within* the subfunction, although there is an obvious interdependence. Motivation is the means of obtaining optimum performance from individuals and managers to the limit of their ability while at the same time increasing this ability through training and self-development. The establishment

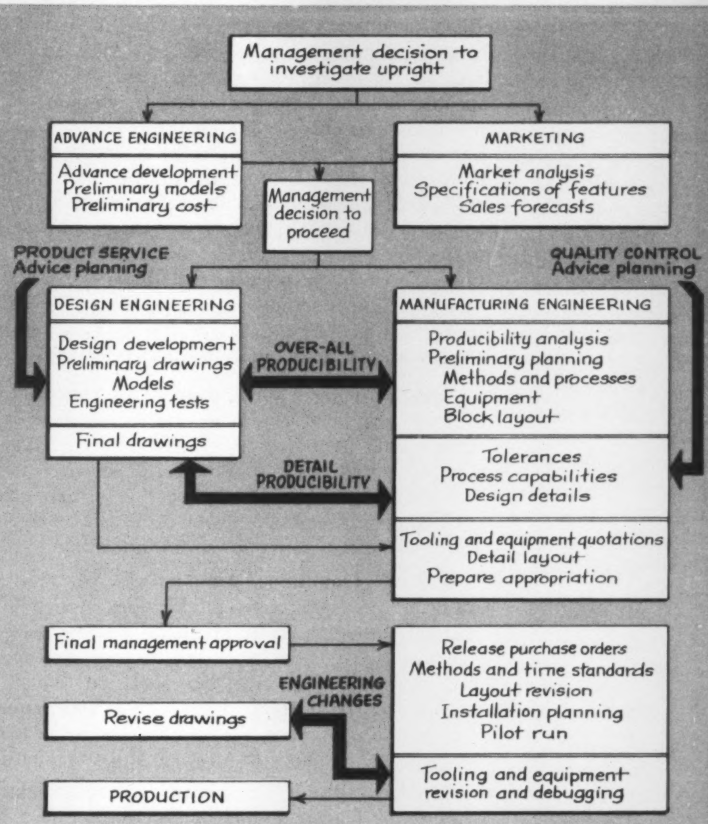

Management decision to investigate upright
ADVANCE ENGINEERING
Advance development
Preliminary models
Preliminary cost
MARKETING
Market analysis
Specifications of features
Sales forecasts
Management decision to proceed
PRODUCT SERVICE Advice planning
QUALITY CONTROL Advice planning
DESIGN ENGINEERING
Design development
Preliminary drawings
Models
Engineering tests
Final drawings
OVER-ALL PRODUCIBILITY
MANUFACTURING ENGINEERING
Producibility analysis
Preliminary planning
Methods and processes
Equipment
Block layout
DETAIL PRODUCIBILITY
Tolerances
Process capabilities
Design details
Tooling and equipment quotations
Detail layout
Prepare appropriation
Final management approval
Release purchase orders
Methods and time standards
Layout revision
Installation planning
Pilot run
ENGINEERING CHANGES
Revise drawings
Tooling and equipment revision and debugging
PRODUCTION

Fig. 7—Chart indicates steps leading to production of a new upright cleaner. This is an example of the project procedure followed in a mass production business for the introduction into manufacturing of a product representing major differences from the existing products.

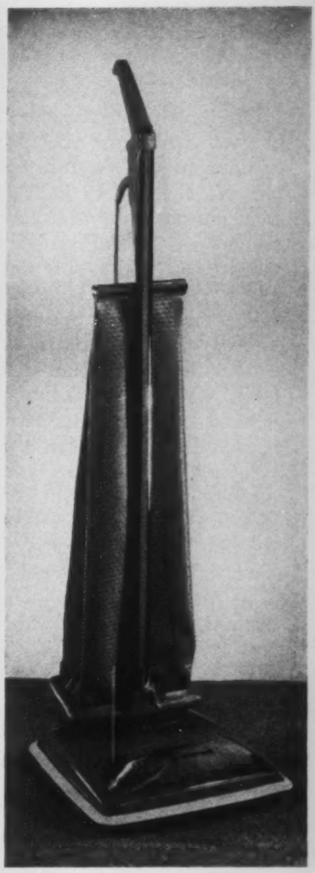


Fig. 8—This upright cleaner is the new product covered by the project outlined in *Fig. 7*. The design put into production includes features worked out jointly by Product Engineering and Manufacturing Engineering to increase over-all producibility.

of effective motivation starts with delegation. Without real and honest delegation of responsibility, authority, and accountability down to the lowest level, it is not possible to inspire the self-confidence necessary for self-motivation. No person can work effectively if he shares a responsibility, or must check with his manager before making routine decisions, or has his manager breathing down his neck, or is afraid to make mistakes. A man must be given a project to do, must understand that he alone will do it and that he won't be watched like a hawk. He must be told how the work fits into the whole, the importance of the project, and must have a voice in establishing the time required for completion. He must know that his manager and others are available for help; and he must be encouraged not only in his successes but also in his failures because effective manufacturing engineering requires the taking of calculated risks. Most really worthwhile manufacturing engineering projects are gambles and the man and his manager must learn to be good gamblers.

▶ Establishing Objectives

The next important phase in motivating manufacturing engineering for effectiveness is the establishment of objectives. The objectives for manufacturing engineering are, of course, essentially timeless and are related to the objectives for the entire business operation. They can be simply stated as follows:

1. Reduce costs through design for producibility, through improved methods, processes and equipment, and by making instead of buying where economical.
2. Research and develop new techniques of advance planning, new methods, new processes, and new equipment.
3. Teach and train personnel for additional responsibilities and provide proper climate for self-development.

4. Continually improve communication and integration with Product Engineering, Marketing, Employee Relations, and other manufacturing subfunctions.

Objectives then become the basis for the setting of goals which are specific and related to a period of time. In the Vacuum Cleaner plant, yearly goals are set each December and revised as necessary each quarter. The Manufacturing Engineering component established sixteen goals for 1958, one of which was "Reduce the unit cost on the C-6 Cleaner 30 cents by 12/31/58." This goal was determined by listing all the cost reduction projects known or contemplated in December, 1957. Projects with a potential unit cost reduction of 22.5 cents were either being worked on or would be worked on during the year. An additional 7.5 cents was added to establish the yearly goal of 30 cents per unit because we knew from experience that additional projects would be completed during the year which were unknown at the time of establishing the goal. Each project was assigned as the responsibility of a single manufacturing engineer. The projected month of completion and estimated savings were determined by the responsible man and his manager, thereby self-motivating the man to meet or exceed his own schedule.

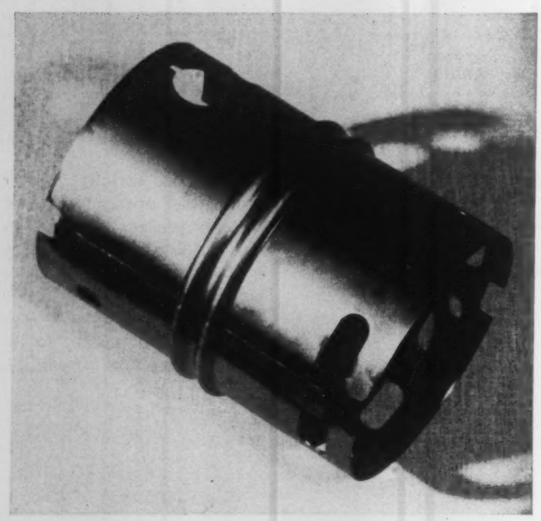


Fig. 9—This sheet metal frame for the motor in the upright cleaner is one of the major keys to producibility of the cleaner. It acts as the inner race of a ball bearing on which the cleaner rolls and is supported; and can be used on a canister cleaner as well.

While this process of motivation results in effective and timely completion of cost reduction projects, it does not ensure that the projects being worked on are the most worthwhile. Project determination and selection are the keys to dramatic results. It is all too easy to get into a trees-and-forest situation. For instance, the Manufacturing Engineering effort can be spent working on a large number of direct labor cost reductions through automation and improved methods, equipment, and processes. Usually every manufacturing operation has enough of these projects in the mill to occupy more than the full time of all the manufacturing engineering personnel. Since these types of projects are obvious to any trained eye they may lead to unhealthy concentration on minutiae while the big items lie dormant because they have not been recognized. The first approach must be to look at the total picture. Depending on the type of business, this approach might apply the following tools:

Manufacturing Cycle Study. The manufacturing cycle is the total time required to produce a finished unit, including productive activity and the nonproductive delays for waiting, storage, repairs, etc. Charting this information, *Fig.* 4, can give an indication of areas where the cycle can be economically shortened, sometimes dramatically.

Material Handling Cost Analysis. Material handling in its total concept includes not only the cost of full-time material handlers but also the time spent by direct labor in grasping, moving, lifting, and releasing of either tools or the product itself. The portion of direct labor time spent in this handling work is appreciable and at least equal in potential savings to that of full-time handling.

Standardization. The advantages of standardization are obvious and need no explanation here. What does need delineation, however, is the responsibility of Manufacturing Engineering for initiating standardization studies to show the potential cost savings. Collation charts, *Fig.* 5, are a useful tool in the development of standardization studies.

Plant and Equipment Utilization Study. An analysis of the utilization of various pieces of equipment will point out both bottlenecks and excess capacity. Correcting both conditions will result in a properly balanced operation, often releasing valuable floor space, reducing maintenance, speeding up material flow, and increasing inventory turnover.

Make Versus Buy Analysis. Aggressive study of all items, whether made internally or purchased outside, will show ability to make substantial reductions in cost both by making more internally as well as by utilizing specialty vendors for parts presently being made. Value Analysis is a useful technique for approaching this work.

Taking this big look, though, is only the start. Usually such a look will disclose so many projects that they cannot all be tackled at once. When projects are evaluated, a relatively small number of them account for a large part of the potential value, *Fig.* 6. By selecting the right combination of projects (with due consideration to the probability of success, the potential dollars of cost reduction, the time to complete, and the manhours of critical skilled manpower), an optimum program can be determined. A problem usually arises when the manufacturing engineers try to work on everything at once—and this is a great danger. It is far better to assign only a very small number of projects to an individual so that he brings each to completion on schedule. If this results in too many lucrative projects going unassigned, it may be necessary to hire more people.

▶ Implementing the Project

Actual project work, of course, varies with scope; some projects require part of the time of one man over an extended period, and others require several men full-time. The work, *Fig.* 7, leading to production of the new upright cleaner, *Fig.* 8, introduced early this year, is an example of a typical large project in our Vacuum Cleaner Department. After the initial management decision to investigate a new upright cleaner, Advance Manufacturing Engineering and Marketing worked in parallel on initial development leading to preliminary costs and a sales forecast. When these appeared to be favorable, a management decision to proceed was made.

Product Engineering took over at this point to complete the design development and make several working models for various tests. During this entire phase, manufacturing engineering knowledge was required to ensure over-all producibility. Three Advance Manufacturing Engineers were assigned to the project on a part-time basis—one a motor specialist, one a tool engineer, and one an advance planner responsible for facilities requirements. Contact between these Advance Manufacturing Engineers and the Product Engineer was frequent and fruitful. Each knew at all times the problems and concerns of the others in time to work out mutually satisfactory solutions.

When Product Engineering was satisfied that the design would meet specified performance and cost requirements, final drawings were started. During this period, the Advance Manufacturing Engineering specialists were advising on detail producibility with regard to tolerances, assembly problems, process capabilities, elimination of operations, depth of draws, finishes, fastening techniques (e.g., riveting versus spot welding), and a host of other points.

As drawings progressed to completion, the Advance Manufacturing Engineers began to work full-time on this project. Tooling and equipment vendors were contacted and brought in for discussions. When drawings were available, the Advance Manufacturing Engineers sent out requests for quotations. The detail layout was started and data were gathered for the Appropriation Request necessary to obtain authorization to spend funds. The Appropriation Request presented a complete picture of the Manufacturing Engineering work in terms of dollars of investment, tooling, and related expense required to put the upright into production. When Management approval was obtained and a start production date scheduled, the assigned Advance Manufacturing Engineers released the tooling and equipment orders.

During the procurement period, Methods and Time Standards personnel were assigned to the detail work of determining workplace layouts, line balance, and time standards. The Advance Manufacturing Engineers continued to work on the project as necessary to follow up on tooling and equipment vendors, revise the detail layout, plan the installation of equipment, and complete a pilot run. During the pilot run the Process Engineers (fire-fighting manufacturing engineers assigned to Shop Operations) were brought in to become familiar

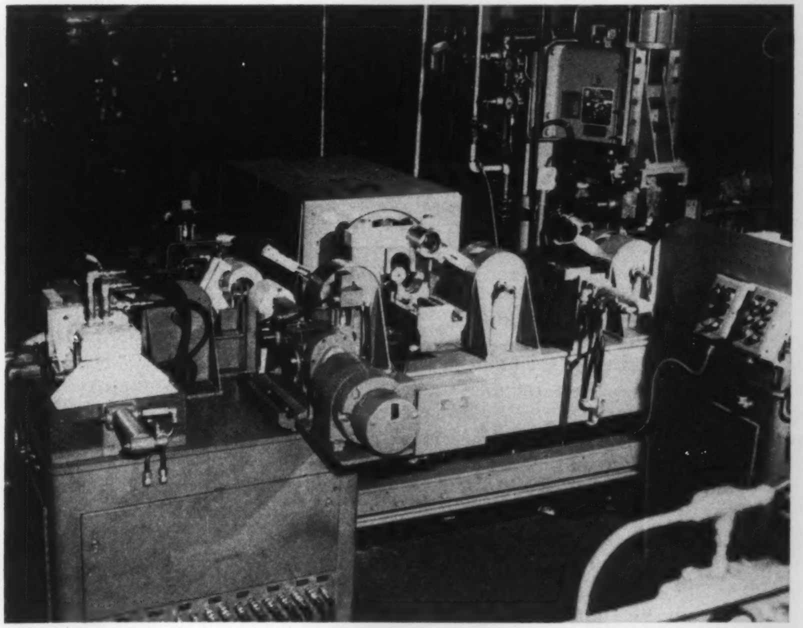


Fig. 10—Integrated automatic line of equipment produces the sheet metal motor frame. The process includes blanking, rolling, welding, expanding, beading the ball race, machining the ends, and piercing the brush-holder holes. An Advance Manufacturing Engineer was in charge of the equipment procurement from the investigation of vendors willing to provide the entire line to the final approval of payment for the equipment.

with the entire project. The Process Engineers gradually took over in the revision and debugging period between the pilot run and full production. Once production started, the Advance Manufacturing Engineers' responsibility was generally over and they were assigned to another advance project.

This outlines the work in general of the Advance Manufacturing Engineer in a large project. To get into his specific responsibilities for equipment procurement it is necessary to look at a part of the entire project. For this purpose, let us consider the sheet metal frame for the upright motor, *Fig.* 9. This frame is one of the major contributions to the producibility of the upright because it is designed to: 1. Replace a higher-cost die casting. 2. Act as the inner race of a ball bearing on which the cleaner rolls and is supported. 3. Be made in our plant instead of bought outside. 4. Be used (without the ball race) on our new canister cleaner motor, thus giving us standardization.

The idea for the development of this particular design originated in Product Engineering. However, as part of the producibility work, the design passed through several stages as two of the Advance Manufacturing Engineers—the motor specialist and the tool engineer—wrestled with the lowest cost method of making this part. They investigated such methods as drawing a cup and cutting off from tubing before settling on blanking, rolling into a tube, mash seam welding and expanding to size. This latter method offered the lowest material cost and most opportunity for automation but had the highest investment.

The motor specialist started equipment investigation with three qualified equipment vendors who would tackle the entire package as one automated process from blanking through rolling, welding, expanding, beading the ball race, machining the ends, and piercing the brush-holder holes. As the design crystallized (including producibility contributions of the equipment vendors), the motor specialist asked for quotations on price and delivery with a guarantee of performance on penalty of no payment. Quotations were received and analyzed thoroughly by the motor specialist with each vendor to ensure that there were no misunderstandings. When appropriation approval was received, the motor specialist had a purchase order issued to the most qualified vendor, who happened in this case to be the low bidder.

While the equipment was being built the motor specialist maintained close and frequent contact with the vendor to make sure that difficulties were taken care of before they became real problems. This close contact was continued, after the equipment was installed, *Fig.* 10, until it was producing at specified quality and rate. The invoice for the equipment was held up until that time and could only be released for payment by the Advance Manufacturing Engineer who had initiated the purchase order.

The above example clearly shows that the full measure of responsibility for equipment procurement in its broadest sense was exercised by the Advance Manufacturing Engineer. He was responsible for producibility of the design, for process selection, for negotiating with equipment vendors, for getting the equipment in the plant on time, for debugging until performance specifications were met, and for releasing payment to the selected vendor. Placing this full responsibility where it has to be for effective machine procurement is an essential ingredient in providing the proper climate and motivation for effective manufacturing engineering. And without effective manufacturing engineering no company can long remain an effective competitor.

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6. Ibid., p. 2-5 and 2-6.
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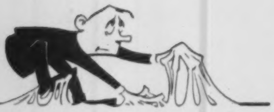

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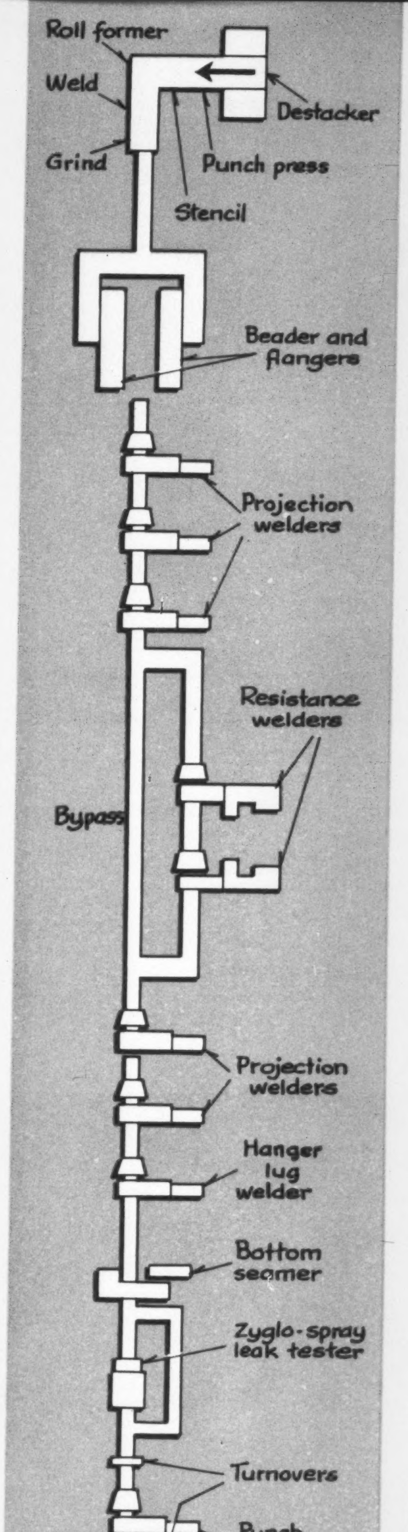
AUTOMATION TODAY

FABRICATING TRANSFORMER TANKS

DISTRIBUTION TRANSFORMERS are found on poles near most homes in the U. S. A. Since the number of homes and the power used in the average home have been increasing, the needs for distribution transformers have also grown. To meet these growing needs, Westinghouse Electric Corp. has engaged in co-ordinated programs to develop improved transformer designs and to develop improved methods and equipment for their manufacture.

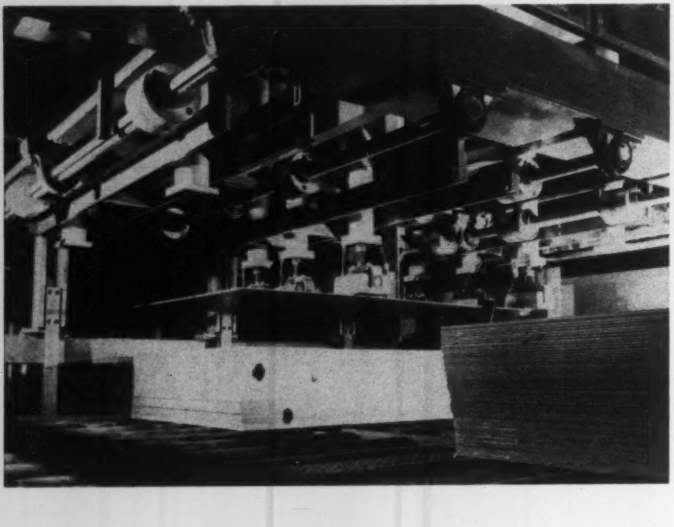
A tangible indication of the success of these interlocked developments is the flow of distribution transformers coming from the new Westinghouse plant at Athens, Ga. This new plant was built to supplement their capacity at two other locations which also manufacture distribution transformers. It is one of the largest Westinghouse facilities in the entire South and was located in Athens to give better service to customers in the southeastern states. Availability of a good labor supply, desirable social and cultural environment, and other economic considerations were also factors in the selection of this particular location.

The Athens production facility receives copper rod, steel, insulating papers, and other materials, and pro-


Roll former
Weld
Destacker
Grind
Punch press
Stencil
Beader and flangers
Projection welders
Resistance welders
Bypass
Projection welders
Hanger lug welder
Bottom seamer
Zyglo-spray leak tester
Turnovers
Punch presses
Dispatch to clean and paint line

1

Equipment to produce tanks for distribution transformers is integrated into a single production line. Steel sheets sheared to size for the shells are brought to the head of the line at top. The fabricated tanks, ready for cleaning and painting, leave the line at bottom. Fifteen major pieces of equipment are involved in the line, and special automatic positioners manipulate tanks for operations at desired radial and longitudinal locations on ten of the machines. Tanks can be fabricated at rate of about 30 per hour.

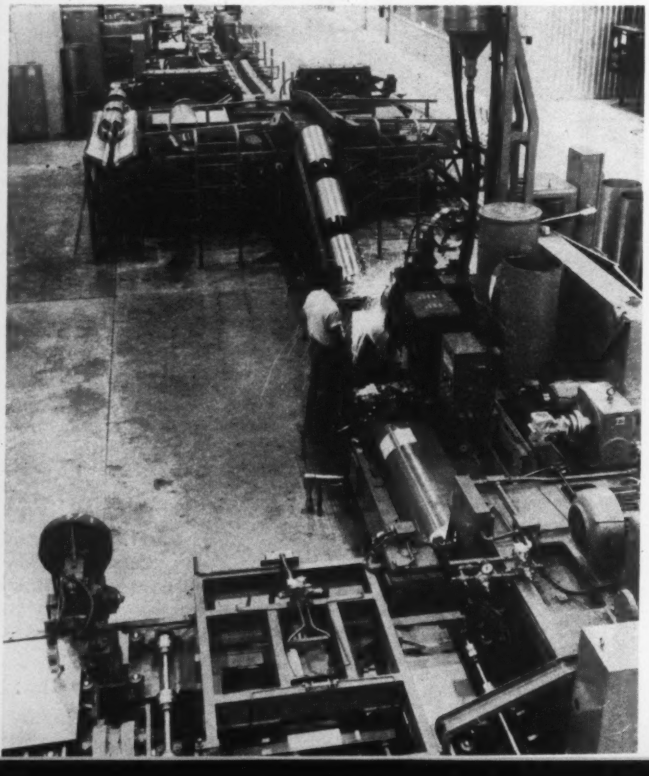


2

Magnetic destacker at head of line feeds sheets for tank shells one at a time to a powered roller conveyor. Top sheet from stack is lifted to rotating magnetic rollers which feed the sheet out at right.

duces pole type distribution transformers rated from 5 to 333 kva. The plant was originally designed to produce units from 5 to 167 kva, but continuing developments made it possible to produce units with higher ratings on the same production lines.

Materials are processed through three main feeder areas—coil manufacture, core production, and tank fabrication. Elements from these areas are combined in a humidity-controlled final assembly room. Each transformer assembly includes a coil, two core units, and the tank which houses the coil and cores. After assembly, the transformer, complete with terminals and cover, is filled with oil, automatically tested under punched card control*, and prepared



3

As sheets from the destacker advance, the small press on the other side of the conveyor at lower left is automatically tripped to punch a hole that is used as a reference point for later operations. The sheet is then marked with the style number and fed into the roll forming operation at lower right. Sheets are rolled into cylinders; these are clamped and advanced longitudinally under a welding head. The forming rolls around the main roll are designed with circumferential grooves which intermesh so that essentially no flat area is formed at leading or trailing edges. Since the cylinders abut against one another as they pass under the welding head, it is not necessary to establish and extinguish the arc for each shell. After the weld is made, it is ground flush with the surface for 3 inches at each end of the shell. A rocking arm breaks the welds between individual shells and they are carried up the inclined conveyor to the beading and flanging machines.

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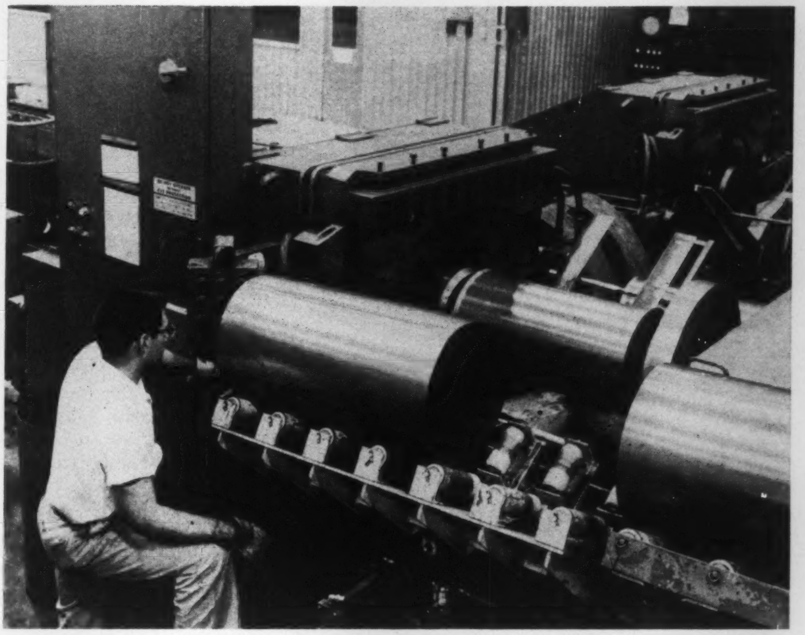
*For details on a similar testing installation, see J. J. Lahm and G. S. Pail—"Programmed Transformer Testing," AUTOMATION, Vol. 6, No. 4, April 1959, p. 70.



4

Two beading and flanging machines are installed in parallel. One of them can be changed over for a different tank size while the other machine is operating. Storage conveyors are also being installed to serve as banks to even out fluctuations in operation of different units. In the beading and flanging machines, a flange is formed on one end of each shell by pressure against a die surface. An external bead is formed on the other end of the shell by rollers expanding and rotating inside the shell.

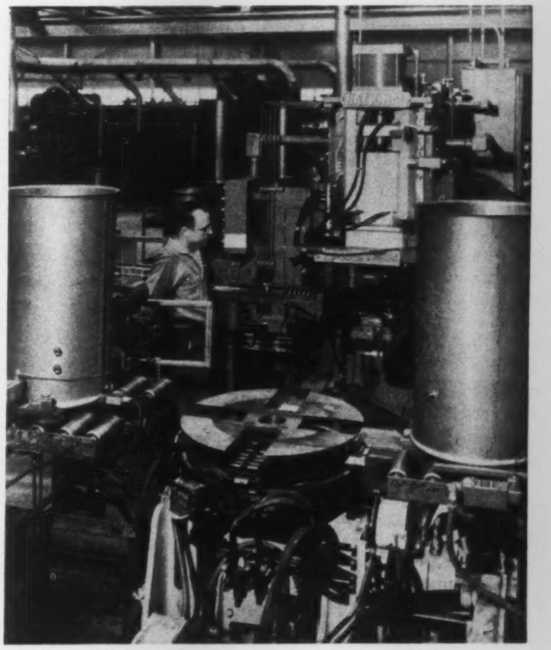
for shipment.

Many special pieces of equipment have been used in each of the main areas of the plant. Perhaps the most spectacular are those in the integrated line of equipment that produces welded tanks complete with cooling fins, other welded attachments, and punched holes for terminals, etc. Stock for the shell of the tank comes to the line as sheets sheared to size. Cooling fins, brackets, and tank bottoms are produced in auxiliary operations and joined to the tank shell on the automated line. Key supplier for this line was National Electric Welding Machines Co.

In developing the designs to be produced on this new line, modifications to previous tank designs reduced the number of variations by 45 per cent. Dif-

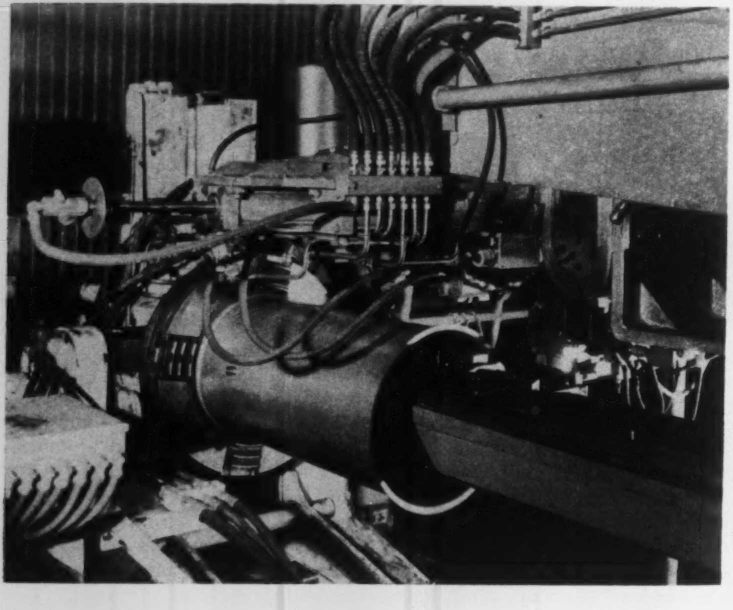
5

Five projection welders, two resistance seam welders, an arc welder, and two hydraulic presses require circumferential and longitudinal positioning of the shells under the working heads for subsequent operations. In this photo an empty positioner is ready to receive a tank shell from the powered conveyor at left. The shell is positioned on the conveyor by vertical rolls which turn it circumferentially until a probe enters the reference hole. The shell is then advanced onto the four-quadrant platform on the positioner and lowered into a four-jaw chuck. The chuck provides several concentric gripping surfaces so that different tank diameters can be run without changing jaws. Another probe checks to be sure orientation of the reference hole has not been altered in the transfer to the chuck, and the chuck clamps the work. Chuck and shell are then tilted 90 degrees toward the workhead.



ferent tank designs are all made from the same gage steel. The number of different types of fins used was reduced from 13 to 4, and fin locations around the circumference of the tank were standardized. To eliminate sticking of the fins to each other, in the magazine feeding them to the assembly point, small dimples were added in the sides of the fins. Locations for terminals and fins along the height of the tanks were also standardized.

The combined result of these developments in product design and production facilities for fabricated steel tanks is illustrated by the accompanying photographs.

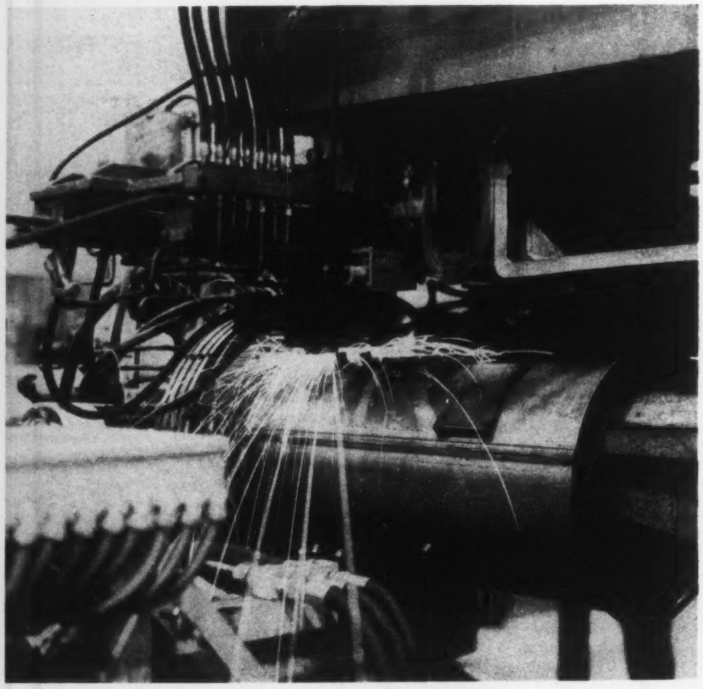


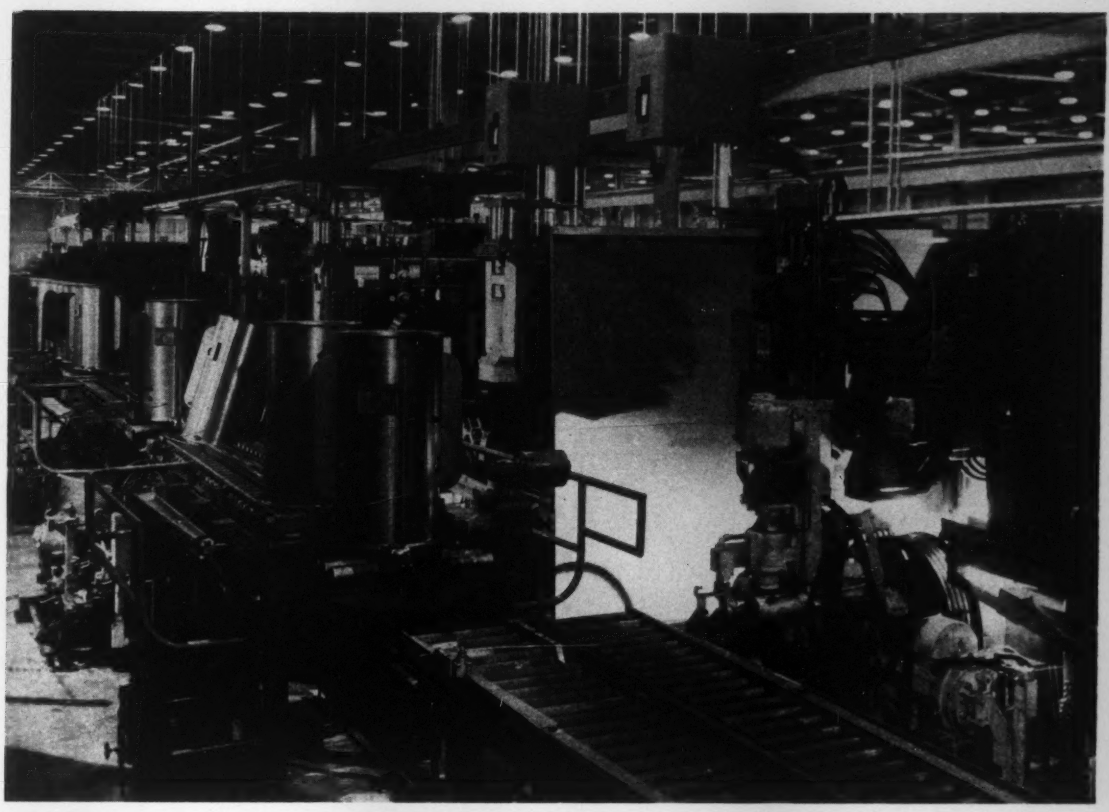
6

After a tank is tilted down it must be positioned circumferentially and longitudinally to desired work positions. Circumferential positions are set up by presetting cams on circular tracks on the chuck. Longitudinal positions are set by cams on tracks carried by the longitudinal positioning carriage. The cams trip limit switches to signal that desired positions have been reached. Cypak static controls automatically sequence the handling and positioning actions. When the welding or punching operations are completed, the positioner backs away from the machine and tilts the shell back up 90 degrees. The chuck releases the shell, and it is raised out of the chuck and discharged to a conveyor.

7

This is one of the five similar projection welders in operation. Standardization of these units was important from the standpoint of maintenance and spare parts stock. These machines weld various pads, lugs, and studs inside and outside the tank. Cooling fins are automatically fed and welded in place by the two resistance seam welders, and hanger brackets are arc welded in place by the arc welder.





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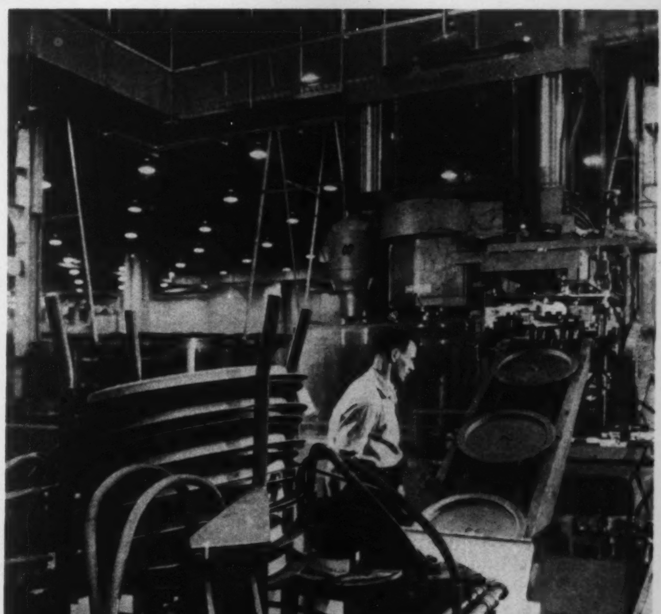
View looking back along line toward the head end shows welding operation being performed on tank at right. Third tank back on line is just being tilted by positioner at that welder. Tanks which do not require fins can bypass the resistance seam welders which are offset from the main conveyor.

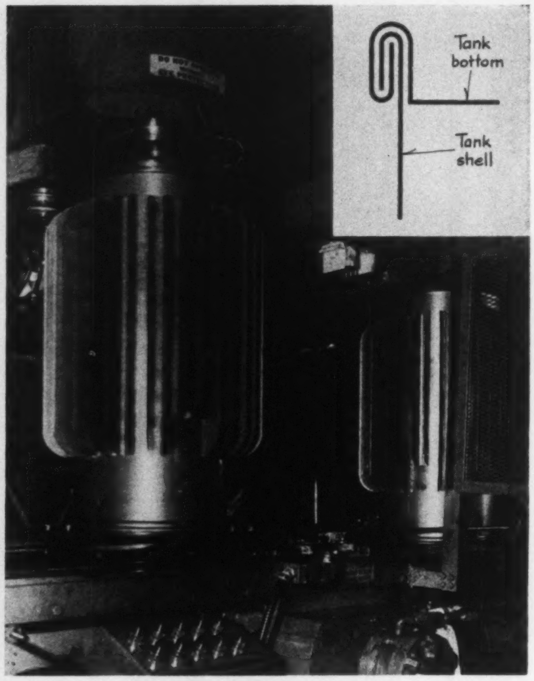


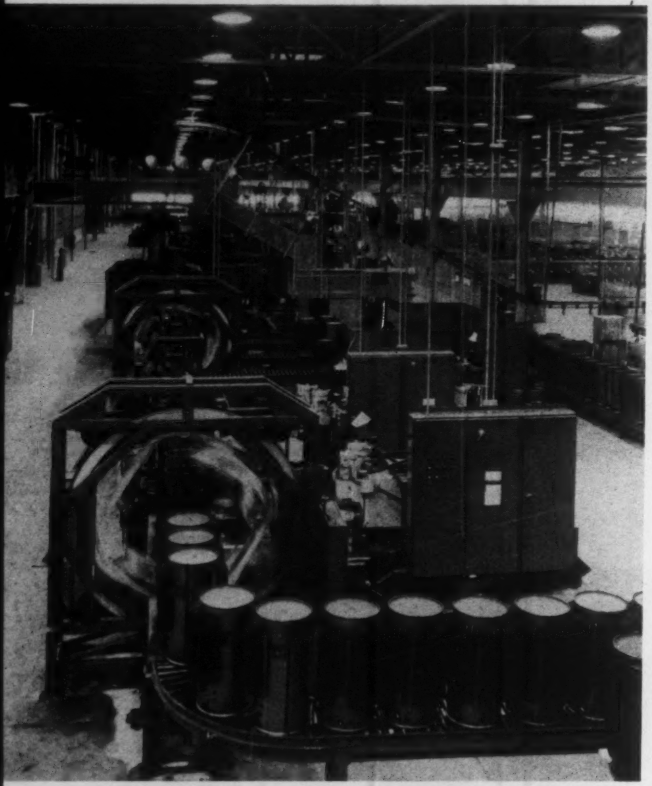
9

Feeding arrangement at left supplies tank bottoms to automatic bottom seaming operation. The bottoms receive sealing compound around the flange and are fed and pressed down into the tank shells which are upside-down on the main conveyor. Small loops previously welded to the bottoms will allow completed tank to be easily carried by overhead conveyor through later cleaning and painting operations with open top down.

10

Photo of seamer shows bottom placing station at right and roll seaming station at left. The bottom seamer folds the bottom over the shell and folds both the bottom and the shell over to form a sealed joint with five thicknesses of steel. The tank is then moved to a leak test station. Zyglo sprayed inside the tank penetrates through any leaks and is detected under black light by an inspector.





11

After being tested, the tanks are turned right side up by an automatic turnover. Automatic positioners can then locate the tanks over the horns of two special hydraulic presses that punch out and form holes for terminal bushings, circuit breakers, and signal lights. Positioning for the press operations is accomplished in the same manner as for the welders. When the tanks are returned to the conveyor they are again upended by a second turnover. Completed tanks in foreground are ready for cleaning and painting.

12

Fabricated tanks are carried through cleaning and painting operations by a continuous overhead conveyor. Coming from the fabricating line on a powered roller conveyor, the tanks are lifted by the elevator shown and hooked to the overhead conveyor. After being painted, the tanks are stored until required on the final assembly line.

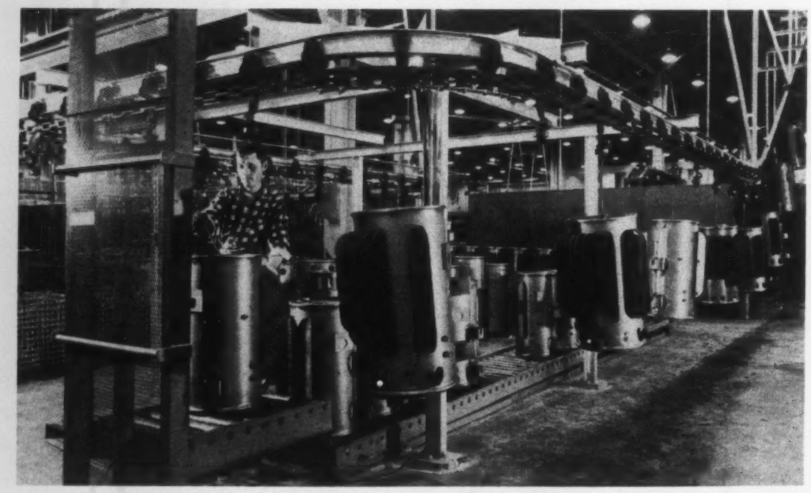
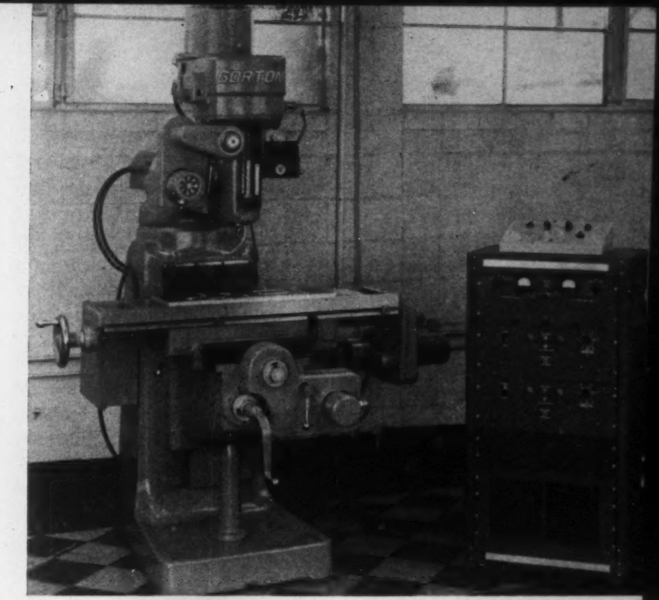


Fig. 1—Gorton Mastermill is shown equipped with a Micro-Path control system. For three-axis contouring, the control equipment directs the cutter through a two-axis contouring program followed by an automatic cutter advance; thus, successive contouring cuts at different levels provide the desired three-dimensioned contour.



PULSE SYSTEM PROVIDES RECORD PLAYBACK CONTROL

HISTORICALLY, record playback control of machine tools stands between the techniques of tracer control and numerical control. In the general sense, it is a technique based upon the proposition that the way to obtain repetitive actions from a general purpose machine is to show the machine how to do the job one time and to record the machine's own actions for playback control of repeat runs. Such a system is related to tracer control in that a template or model tracing technique can be used to generate playback control information; it is also related to numerical control in that a recorded signal can subsequently be used to direct the machine.

Micro-Path Inc., a division of Topp Industries Inc., manufactures a versatile record playback system that can be used for both point-to-point and continuous-path control of machine tools, *Fig.* 1. A program is placed on magnetic tape by moving the slides of a machine through the desired motions. Flexibility as to where the tape is prepared is provided in that the machine may be the actual machine tool or a special stylus-equipped recording table.

Key components in the control system are special pulse-operated servomotors and the associated control elements which generate pulses to actuate the servomotors. A servomotor is required for each motion to be controlled. The unit is connected to a drive shaft through gearing or timing belt reductions, *Fig.* 2. With this arrangement, the output of the servomotor may be translated to a desired feed rate and position accuracy resolution through selection of appropriate reduction ratios.

During programming, pulses are generated by the control system to move the slides and are recorded on an 11 channel magnetic tape. Eight of the channels (two channels for each direction along two axes) are used to store motion information; one channel controls internal auxiliary functions; one channel controls external auxiliary functions; and one channel contains the execute commands for the auxiliary functions. The duplicate channels used for each direction of motion along an axis are not next to each other—a provision that guards against the loss of information because of slight tape imperfections.

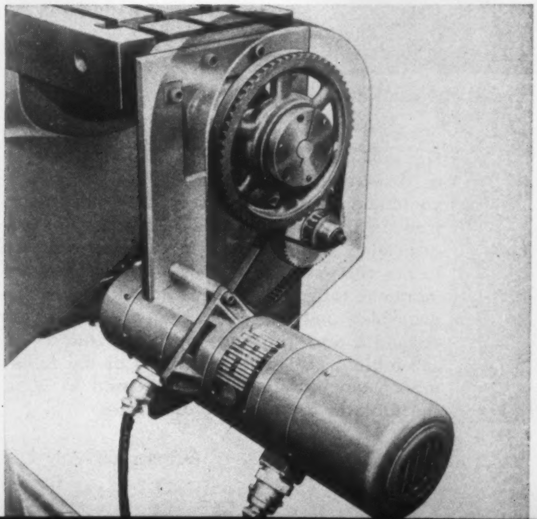


Fig. 2—Pulse-operated servomotor is required for each controlled axis. The unit may be connected to machine tool through gear or timing belt reductions. Supplied in ⅛ to 3 hp inputs, unit provides traverse speeds up to 100 inches per minute.

▶ Tape Preparation

For positional programming, each controlled axis is also supplied with feed rate and directional controls, a position reader, and a toggle switch which can select either a high or low feed range, *Fig.* 3. In preparing a positioning program, the slides are moved to a desired reference point and the position indicator is then zeroed. The recording controls are then turned on and the operator manipulates the axis controls. The electronic system generates the pulses to drive the slides in the indicated direction and at the desired rate. Simultaneously, the pulses are also recorded on the proper channels of the magnetic tape.

When the desired position is reached, as shown by the position indicator, slide movement is stopped and the operator programs on the tape the auxiliary functions necessary to complete the machining operation at that point. This procedure is repeated for successive points in the program.

To simplify the operator's task in programming accurately, the system provides that recording takes place at 1/4 actual speed, i.e. during programming, the slides only move at 1/4 the speed they will move under tape control during a machining operation. Positions can be located within an accuracy of ±0.001, and at any desired point on the tape it is possible to introduce check figures which must be satisfied before the machine tool will continue to operate.

For continuous path programming, the machine can be equipped with a special recording stylus that can be made to reflect movement in any two of three planes, *Fig.* 4. By applying slight pressure to the side of the stylus as it is guided over a path determined by a drawing, layout, template, or actual part, information is conveyed to the electronic system and pulses are generated to simultaneously move two slides. As in positioning control, the pulses are recorded on magnetic tape as they are generated. For three-axis contouring applications, the machine tool program consists of a succession of two-axis programs recorded in one plane and separated by automatic advances of the cutter along the third axis. Calculation of cutter offset is unnecessary since the stylus can be provided with an end which is of the same diameter as the cutter to be used during machining.

The control builders anticipate the use of the basic system in a variety of control applications. It can be designed into new machine tools; applied to existing machine tools; or used for control operations involving transfer mechanisms, valve positioning, switch positioning, telemetering control, etc. As an example, for machine tool applications, individual servo units may be purchased for adaptation of existing equipment, or a self-contained positioning table can be procured and used to locate work beneath a spindle. Of special significance to smaller plants, the record playback technique provides a means of obtaining the benefits of numerical control but does not require expensive computing equipment for the tape preparation phase.

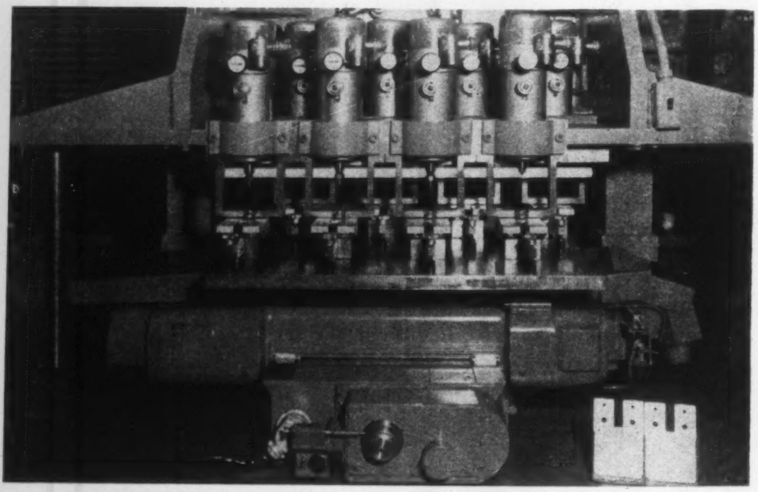


Fig. 3—Special machine containing eight vertical drilling heads is used to produce check cancelling dies. The eight workpieces being machined simultaneously are mounted on a magnetic tape controlled contour table. Control gear (selector switch, toggle switch, position indicator, etc.), which operator uses in manually directing one axis of the table during a programming operation, can be seen at point plastic covered cable connects to the controller.

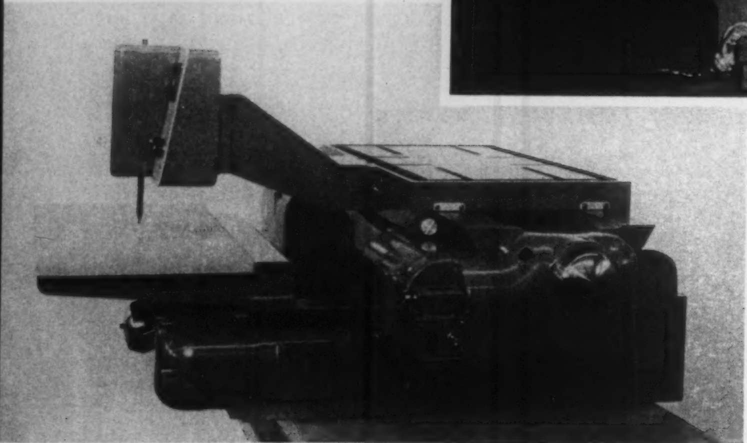


Fig. 4—Contour table contains two pulse-operated servomotors and provides a two-axis self-contained unit for continuous path milling controlled from magnetic tape. The outrigger programming unit and sub-table (left) attached to the contour table permit preparation of the magnetic tape. The stylus attached to the programming unit can be guided by an operator around a part, drawing, or layout fixed on the sub-table. The taped recording of the table's motion would subsequently be used to direct the table in a machining operation.

CONTINUOUS FEEDING SYSTEM MAINTAINS WEIGHT RATIOS

SMALL particles of iron ore are prepared for charging into a blast furnace by sintering—the processing of ore fines into larger-sized particles by fusing the ore particles with flue dust and granular coke. The principle of the operation is to proportion the ore and fuel such that, with combustion, the ore will not be melted to the point at which it runs but will form a cohesive mass.

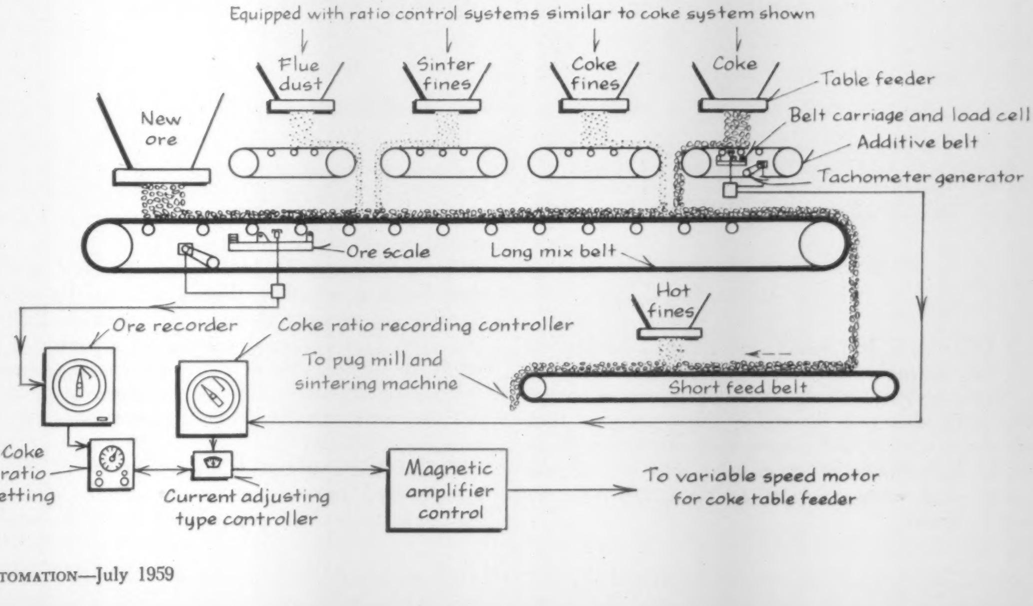
In a sintering plant, bulk material is fed from hoppers in controlled amounts onto a conveyor belt. The material is conveyed to a pug mill for grinding and mixing and is then evenly deposited on a traveling grate. The grate passes through an ignition furnace where the fuel charge is ignited, after which combustion is sustained by a forced downdraft through the burning bed. At the end of the sintering machine the product passes through an air cooler and is then collected for transportation to the blast furnace.

A sintering plant at the Cleveland works of the Jones & Laughlin Steel Corp. regulates the amount of material fed to the sintering machine by an integrated control system supplied by Trans-Weigh Co. The system automatically controls the flow rates of the materials in proportion to each other and permits the operators to vary the ratios involved or to switch to manual control.

Twelve weighing units, which weigh the moving material at every important stage of the sintering operation, are employed. Instantaneous flow of traveling material on a conveyor is measured by determining the weight on a short section of belt and the belt speed. Three major components comprise a basic unit: An electric tachometer generator that detects belt speed; an electric strain gage load cell which measures the weight on the belt; and a special electronic potentiometer which indicates and records instantaneous flow in tons per hour.

The accompanying schematic diagram illustrates the application of these weighing units in a coke ratio system—one of four integrated ratio systems used in the Jones & Laughlin operation. The other three systems—for flue dust, sinter fines, and coke fines—are of the same general type. In the coke ratio system, coke is added to the main flow of material in some desired proportion to the weight of ore on the main conveyor belt. The weight of ore is sensed by a weighing unit on that belt. This weight signal is modulated in accordance with a setting on the coke ratio control and, through a magnetic amplifier circuit, controls a variable speed motor that operates the coke table feeder. The actual amount of coke coming from the feeder is sensed by a scale unit associated with a short additive conveyor belt below the coke hopper, providing the feedback of information to complete the automatic control circuit.

Schematic diagram indicates the relation of several of the major elements that provide proportional feeding of materials in a sintering plant. Feeders for flue dust, sinter fines, and coke fines are controlled in a manner similar to the illustrated coke system.


Equipped with ratio control systems similar to coke system shown
Flue dust
Sinter fines
Coke fines
Coke
Table feeder
New ore
Belt carriage and load cell
Additive belt
Tachometer generator
Ore scale
Long mix belt
Hot fines
Ore recorder
Coke ratio recording controller
To pug mill and sintering machine
Short feed belt
Coke ratio setting
Current adjusting type controller
Magnetic amplifier control
To variable speed motor for coke table feeder

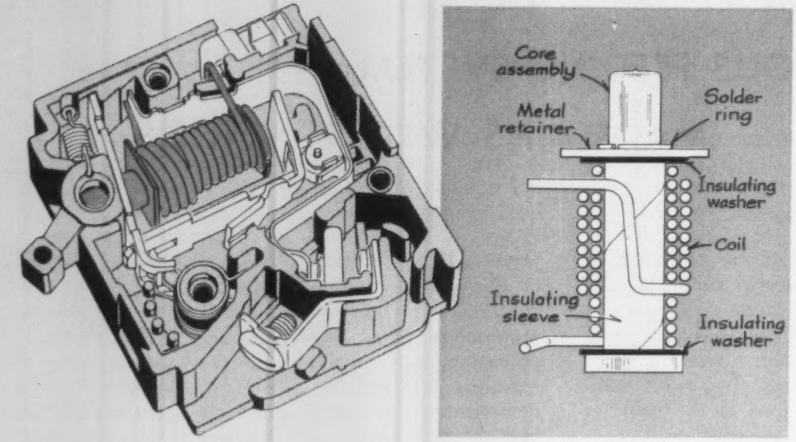


Fig. 1—Assembly outlined in color in cut-away sketch of circuit breaker is detailed in enlarged view. Called a coil assembly, device generates a magnetic field that varies in strength according to magnitude of current flow and number of turns in coil. Function is to attract an armature and trip circuit breaker on overcurrent.

CIRCUIT BREAKER MANUFACTURE

PRODUCING COIL ASSEMBLIES

Manufacturers are becoming increasingly aware of the cost and product quality benefits inherent in automatic assembly. As a result, interest is growing in the design principles used in equipment that performs this manufacturing function. Many of the work-performing, handling, and control features of a machine that automatically assembles a complex circuit breaker item are applicable in other types of automatic assembly equipment.

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IT HAS BEEN SAID that efficient equipment for assembly can show greater labor savings than any other single type of industrial equipment. To this can be added the statement that such equipment is often capable of producing products to higher quality standards, with more uniformity, and with less chance for error than by manual means.

These potentials were recognized by Murray Mfg. Corp. when it came time for them to consider ways and means for producing coil assemblies for their new line of circuit breakers, *Fig.* 1. As a result, Halm Instrument Co. Inc. was authorized to design and build a machine that could do the coil assembly job automatically. The machine that was provided, *Fig.* 2, was developed as a part of a program for automating as many phases of the manufacture of the new line of breakers as could be justified economically (see AUTOMATION, Oct. 1958 and Jan. 1959).

Operations performed automatically by the 16-station dial indexing machine include assembling basic circuit breaker components and subassemblies, forming and assembling a solder ring, and electric resistance soldering. Although only nine stations are used, a 16-station indexing dial was chosen for three reasons: 1. To permit adding work or inspection stations if the need should arise. 2. To provide physical room for some of the more bulky workstations used. 3. To provide idle stations for cooling action to take place after soldering.

A plan view of the machine, *Fig.* 3, illustrates the layout of the workstations and the operations performed at each station. Auxiliary equipment includes electrical controls with fault-location indicators; hopper and magazine feeders; strip supply reels; an electric resistance soldering unit; and a belt conveyor that delivers coils wound on an automatic coil winder.

Safety and maintainability were placed high on the list of design requirements for the machine. In the event of a machine jam or failure of a critical part to feed, the machine is stopped automatically and a fault-location indicator pinpoints the source of the trouble. Also, the indexing plate that carries

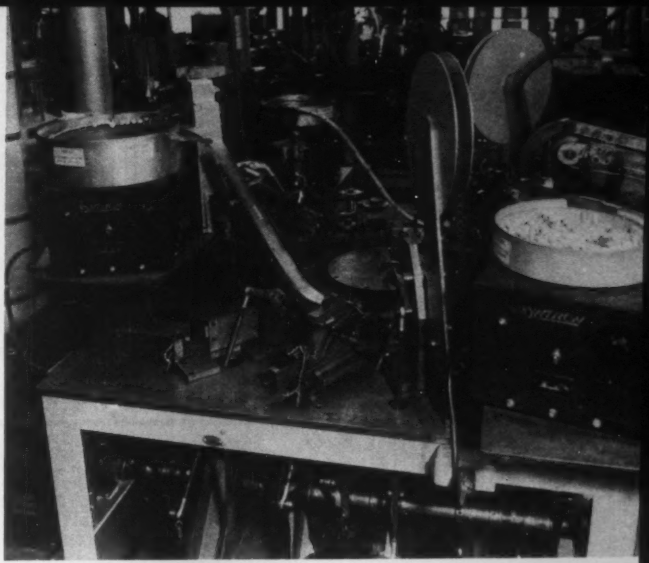

Fig. 2—Automatic assembly machine is a 16-station dial indexing type. Operations include assembling basic circuit breaker components and subassemblies, fabricating and placing a solder ring, and electric resistance soldering. Output of machine is 15 coil assemblies per minute.

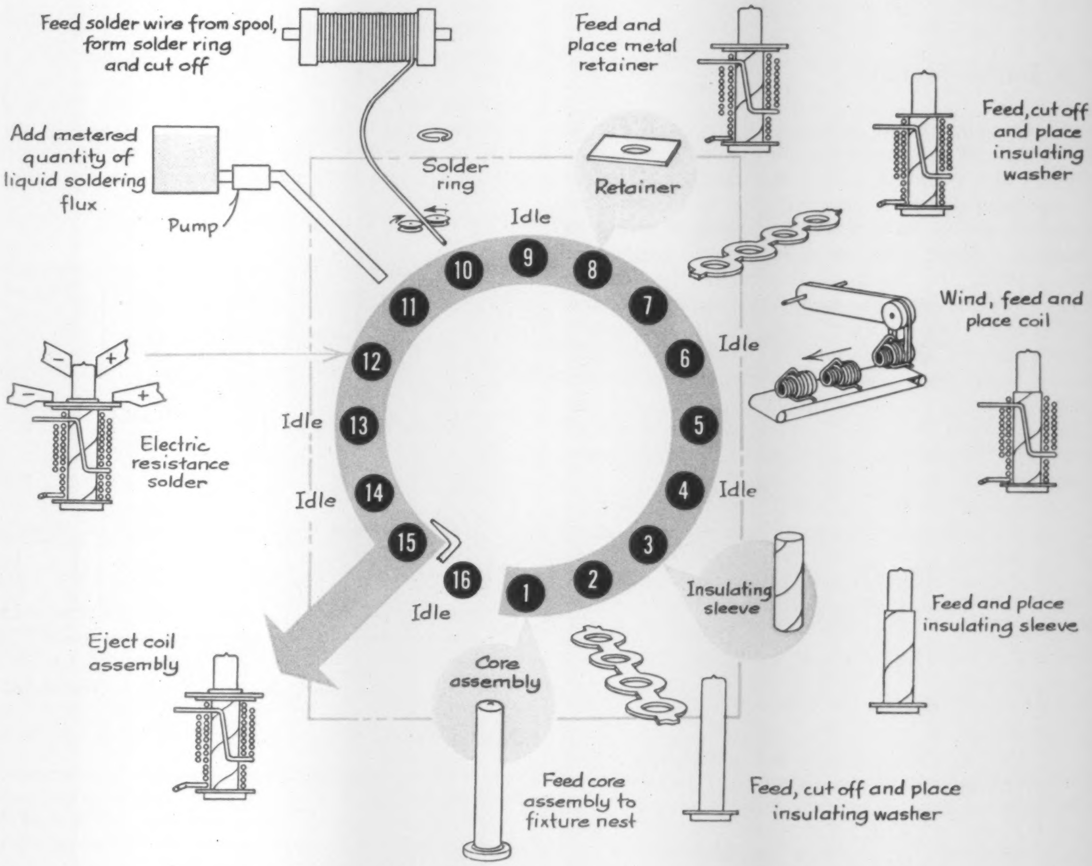
Feed solder wire from spool, form solder ring and cut off
Feed and place metal retainer
Feed, cut off and place insulating washer
Add metered quantity of liquid soldering flux
Pump
Solder ring
Retainer
Idle
10
9
8
11
7
Wind, feed and place coil
12
Idle
6
Idle
13
5
Electric resistance solder
Idle
14
4
Idle
15
3
16
1
2
Idle
Insulating sleeve
Feed and place insulating sleeve
Eject coil assembly
Core assembly
Feed core assembly to fixture nest
Feed, cut off and place insulating washer

Fig. 3—Schematic plan view of assembly machine illustrates operations performed at various stations. Of 16 available stations, 9 are in use; others were provided for possible future requirements or to allow space for some of the more bulky workstations.

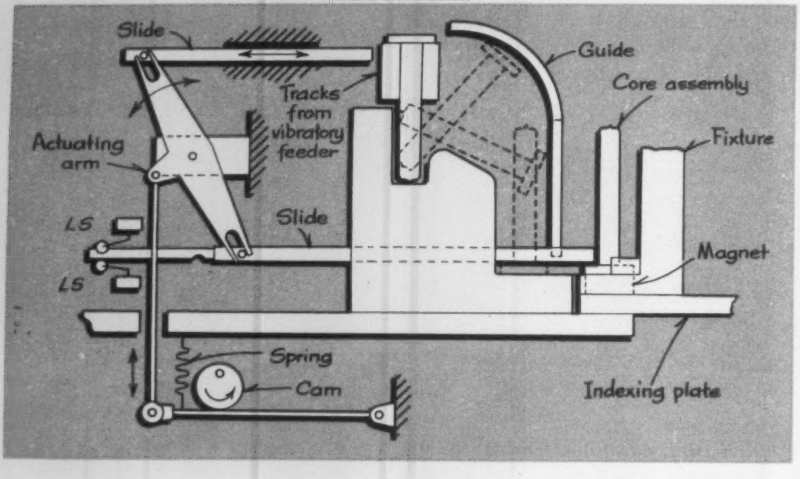

Fig. 4—Core assemblies are fed to fixture nests at Station 1 by two-slide mechanism. Top slide removes leading part hanging on feed tracks, and bottom slide pushes it into dial fixture where it is clamped by spring-loaded finger and held square by magnet. Limit switches sense fully advanced and retracted conditions of bottom slide.

the fixtures is driven by spring-clutch pressure so that, if a machine jam occurs, the full torque of the indexing drive will not be applied to the plate, fixtures, or tooling. A drift pin is used to restore the alignment of the plate with the indexing drive when shifting occurs due to a jam.

▸ Station Features

Core assemblies are delivered to Station 1, *Fig.* 4, by a pair of feed tracks leading from a vibratory feeder. An actuating arm of the station mechanism is operated when a cam on the main machine camshaft rotates to a position allowing a spring to contract. When a fixture is in its dwell position at the station, the mechanism removes the leading core assembly from the feed tracks, inverts it, and places it in the fixture. A magnet in the fixture base holds the core assembly in a vertical position ready to receive additional components at subsequent stations. Limit switches tied in with the control and fault-locating circuits sense whether or not the station mechanism reaches its terminal positions in each work cycle.

At Stations 2 and 7, *Fig.* 5, insulating washers are automatically fed from strips, cut off, and placed. These stations employ the same type of actuation—spring force to advance the mechanisms and cam action to retract them—as do other stations where the concept can be applied. This design limits the forces that can be exerted on the mechanisms when they contact parts or fixtures, and ensures positive retraction so that the fixtures will be cleared for indexing.

Tubular insulating sleeves are assembled to core assemblies at Station 3. This proved to be one of the more difficult assembly jobs, since many of the thin-walled, slender parts are deformed when fed. In particular, crimping of the ends of the sleeves occurs during shipping, handling, and feeding. The solution adopted, *Fig.* 6, was to insert the sleeves on the core assemblies at an angle. In this manner, the sleeve ends can readily engage the core assemblies and, if necessary, be reformed gradually as the sleeves are raised to the vertical position by an escapement pawl. A limit switch at the station senses the presence of an insulating sleeve, and will stop the machine and actuate a fault-location light if a sleeve is not present.

Coils used at Station 5 are wound on an associated automatic coil winder, *Fig.* 7. This machine, a Halm Instrument Co. Inc. product, can be set up to wind any of five types of coils. The rating of a given circuit breaker model is determined by the type of coil used. For example, a breaker model that has a coil with many turns of wire in multi-

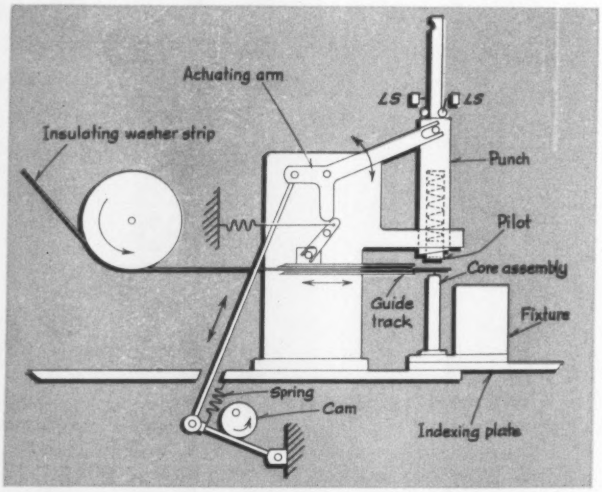

Fig. 5—Sketch illustrates basic elements of mechanism used at Stations 2 and 7 to feed, cut off, and place insulating washers on core assemblies. First portion of working stroke of actuating arm feeds leading washer on strip over core assembly. Pilot then enters hole in washer and seats on top of core assembly. Punch continues to lower, severing leading washer and seating it positively. Pilot retracts into punch during latter action.

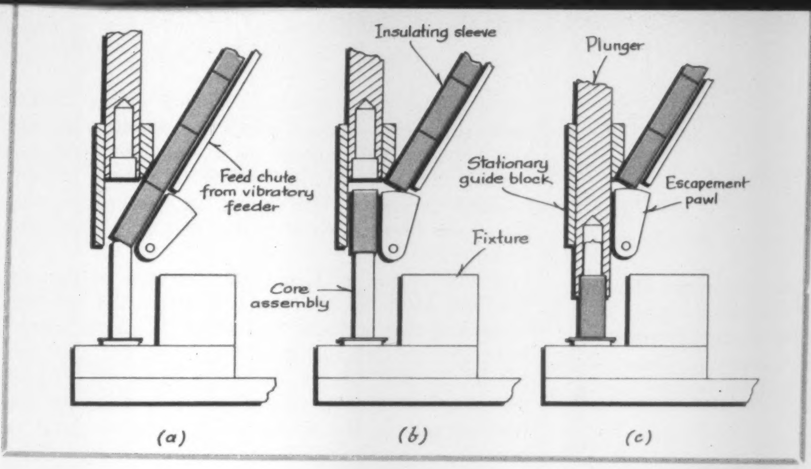

Fig. 6—Insulating sleeves are assembled to core assemblies at Station 3. In order to insure that fragile, possibly deformed sleeves will assemble properly, they are introduced at an angle *(a)*. Escapement pawl lifts leading sleeve to a vertical position over core assembly *(b)*. A plunger then descends to seat sleeve on previously assembled insulating washer *(c)*.

layer form will trip on lighter currents than one which uses a coil of fewer turns in a single layer. The five coils shown provide a choice of operating current ratings of 15, 20, 30, 40, and 50 amperes.

Winding of coils is in response to commands from two limit switches on the magazine at Station 5, *Fig.* 8. When the supply of coils in this magazine is low, the limit switches sense this condition and start the coil winder and a belt conveyor. Coils from the winder are automatically picked up, placed on the belt conveyor, and dropped in oriented fashion in the station magazine. When the supply of coils in the magazine has been replenished, the limit switches turn off the winder and belt conveyor. Since the winder produces coils at a rate about 15 per cent faster than they are used by the assembly machine, an adequate supply is easily maintained.

The bottom coil in the magazine at Station 5 is moved into position over a waiting fixture by a slide. An assembly consisting of an inner and outer plunger then descends. The inner plunger first threads through the ID of the coil and contacts the top of the core assembly in the fixture. This plunger serves as a guide for the coil, which is inserted over the insulating sleeve by lowering of the outer plunger. The inner plunger retracts into the outer plunger during this motion.

Each fixture arriving at Station 6 (an idle station) should contain a partial assembly consisting of a core assembly, insulating washer, insulating sleeve, and a coil. Another insulating washer is added at

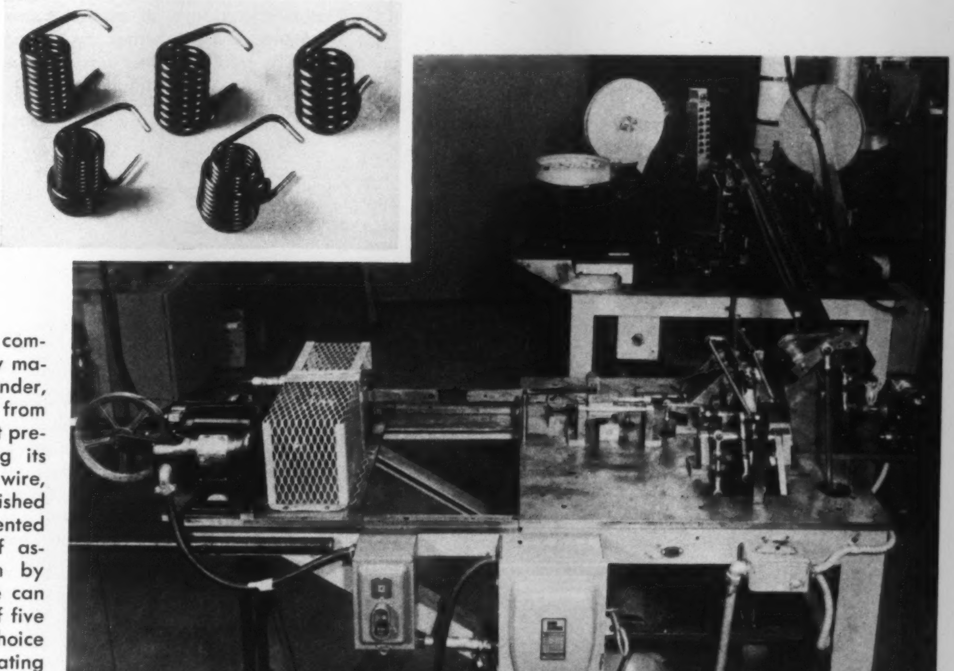

Fig. 7—Operating on command from the assembly machine, automatic coil winder, foreground, feeds wire from a reel, strips insulation at predetermined points along its length, winds coils, cuts wire, and forms coil ends. Finished coils are delivered in oriented fashion to magazine of assembly machine station by belt conveyor. Machine can be set up to wind any of five types of coils, inset. Choice of coil establishes operating current rating of circuit breaker being produced.

Station 7. At this station, washers are placed on top of the insulating sleeves.

At Station 8 a metal retainer is hopper fed and placed in the fixture. The fixture is used as a locating device, *Fig.* 9, because of the necessity of maintaining a predetermined dimension from the bottom of the core assembly to the bottom of the retainer. This dimension must be held within ±0.002 inch, since the retainer serves to establish the air gap between the bottom of a completed coil assembly and the circuit breaker armature in the finished product. Uniformity of performance of the circuit breakers requires that this air gap be held within close limits.

A solder ring is formed around the portion of the core assembly that projects above the retainer in each fixture indexed to Station 10. This proved to be another difficult operation to iron out. Success of the method finally developed, *Fig.* 10, hinged on adoption of a snubbing principle whereby the leading end of the solder wire being wrapped is pressed against the core assembly preparatory to cutting the wire and final-forming the ring.

It is interesting to note that the method of fabricating and placing solder rings used in this machine differs from the one employed at Station C2 of the core assembly soldering machine (see AUTOMATION, Oct. 1958). In each case, technical and economic considerations influenced the particular method used.

Several reasons dictated the technique employed at Station 10 of the subject coil assembly machine: 1. The projecting core assembly was available to act as a winding mandrel. 2. The solder wire used is relatively fine, thus easily formed. 3. Preformed rings having the required ratio of ID

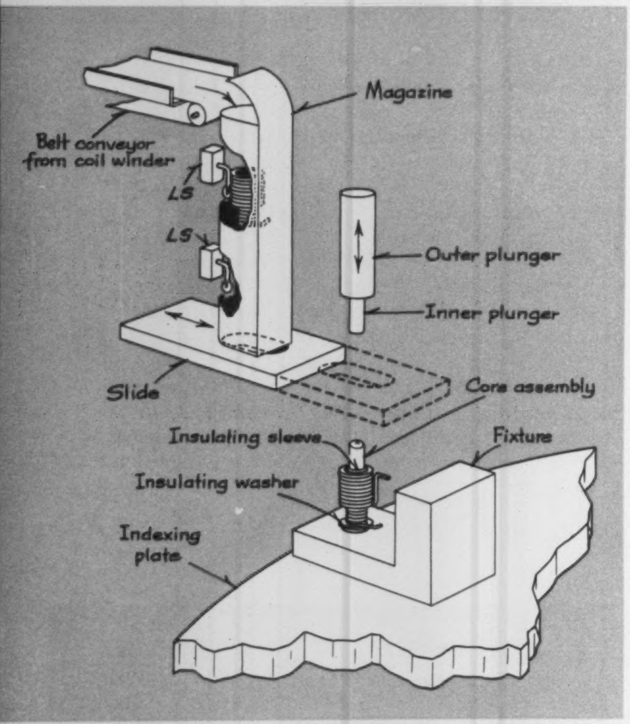

Fig. 8—Coils produced on automatic coil winder are delivered by belt conveyor to loading mechanism at Station 5. Slide removes bottom coil from stack in magazine and places it over fixture. Inner and outer plungers descend to position and assemble coil over insulating sleeve of partial assembly in fixture. Limit switches sense whether or not an adequate supply of coils is available in magazine; when supply needs replenishing, coil winder and belt conveyor are started automatically.

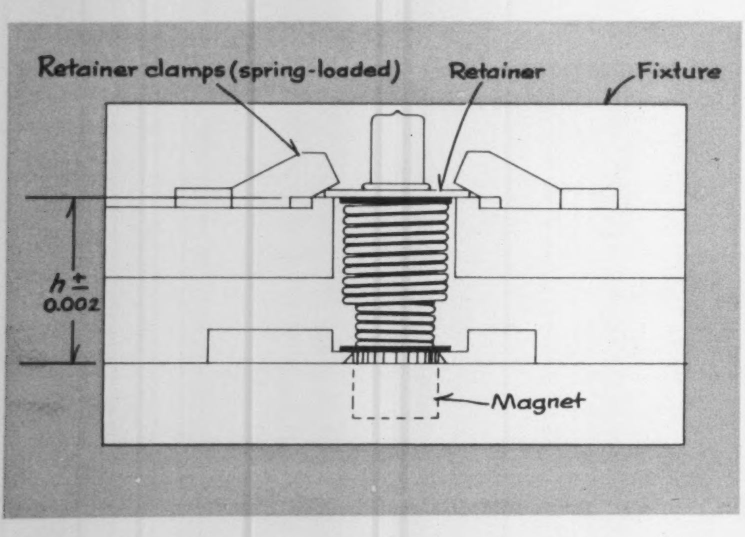

Fig. 9—Metal retainers added at Station 8 are clamped in fixtures by spring-loaded fingers. Fixtures are designed to position parts so that critical dimension from bottom of core assembly to bottom of retainer can be held within close limits.

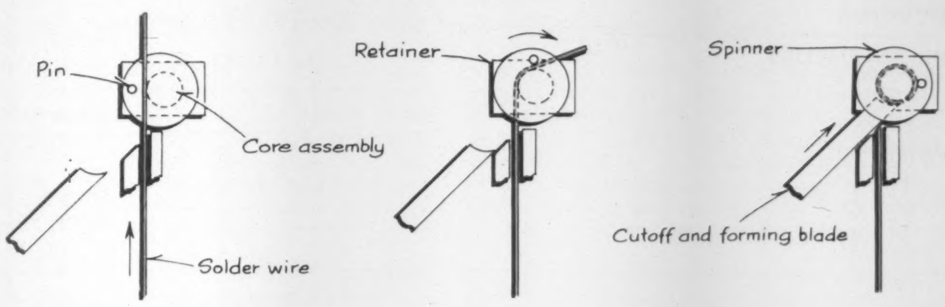

Fig. 10—Solder rings are formed in place around core assemblies and cut off in three-step process at Station 10. In first step, *(a)*, solder wire from a spool is advanced so that its end projects a predetermined distance past the coil assembly in a fixture. Wire passes over retainer, between core assembly and a pin in a spinner. In second step, *(b)*, spinner is rotated so that pin wraps wire end around core assembly. Rotation continues until wire is snubbed against core assembly due to eccentricity between axes of spinner and core assembly. In third step, *(c)*, cutoff and forming blade advances to sever wire end and final-form ring around core assembly. Spinner is reversed and swung away, and blade is retracted, to complete cycle.

to wire diameter would be subject to tangling and deformation if handled excessively.

Other factors decided the method used in the core assembly soldering machine: 1. No suitable projection was available on the part. 2. The solder wire diameter was relatively large, and the ring ID small, which would have made forming in place a difficult operation even if a mandrel were supplied. 3. The rings could be handled readily. In this case, an economical separate operation was employed in which the wire is wound helically and slit, and the resulting rings are flattened. The rings are then hopper fed and placed on the tops of the core assemblies.

At Station 11 of the coil assembly machine, a metered quantity of noncorrosive liquid flux is dropped on the solder ring from a nozzle at the end of a flexible plastic hose. An adjustable stroke, positive displacement pump, operated by a cam on the machine, is used to control the amount of flux delivered in each work cycle.

The solder ring is melted by heating the retainer and the upper portion of the core assembly at Station 12. This is accomplished by passing separate electrical currents between two pairs of electrodes—one pair contacting the ends of the retainer and the other pair closed against opposite points on the core assembly above the solder ring. The current for each pair of electrodes is separately adjustable at the soldering unit. This permits compensating for the different conductivities of the heated parts, so that the over-all heating effect at the solder ring is balanced.

After they have been soldered at Station 12, completed coil assemblies—representing 50 per cent of the manufacturing cost of the circuit breakers—are indexed through two idle stations and then to Station 15 where they are ejected automatically. The purpose of reserving two idle stations between the soldering and ejecting stations is to allow time for the assemblies to cool.

▶ Electrical Controls

Multistation assembly machines of this type usually involve the continual performance of many complex actions. An adequate control system that can interlock these actions, initiate them at the proper times, and shut the machine down in the event of malfunctioning, is an absolute necessity. The value of such a control system is further enhanced when it contains means for automatically sensing and pinpointing critical failures that cause machine shutdowns.

In addition to its normal function of controlling the machine, the control system for the coil assembly machine, *Fig.* 11, actuates a series of signal lamps to identify major types of faults. These faults include failure of machine slides to advance or retract fully, and failure of a critical circuit breaker component to be assembled when it should. Lighting of any fault-indicating lamp is automatically accompanied by a machine shutdown.

Control actions for normal operation of the machine, and some which occur with various types of malfunctions, are described in the box accompanying *Fig.* 11. Reference to the electrical circuit diagram, *Fig.* 11, will facilitate following these actions.

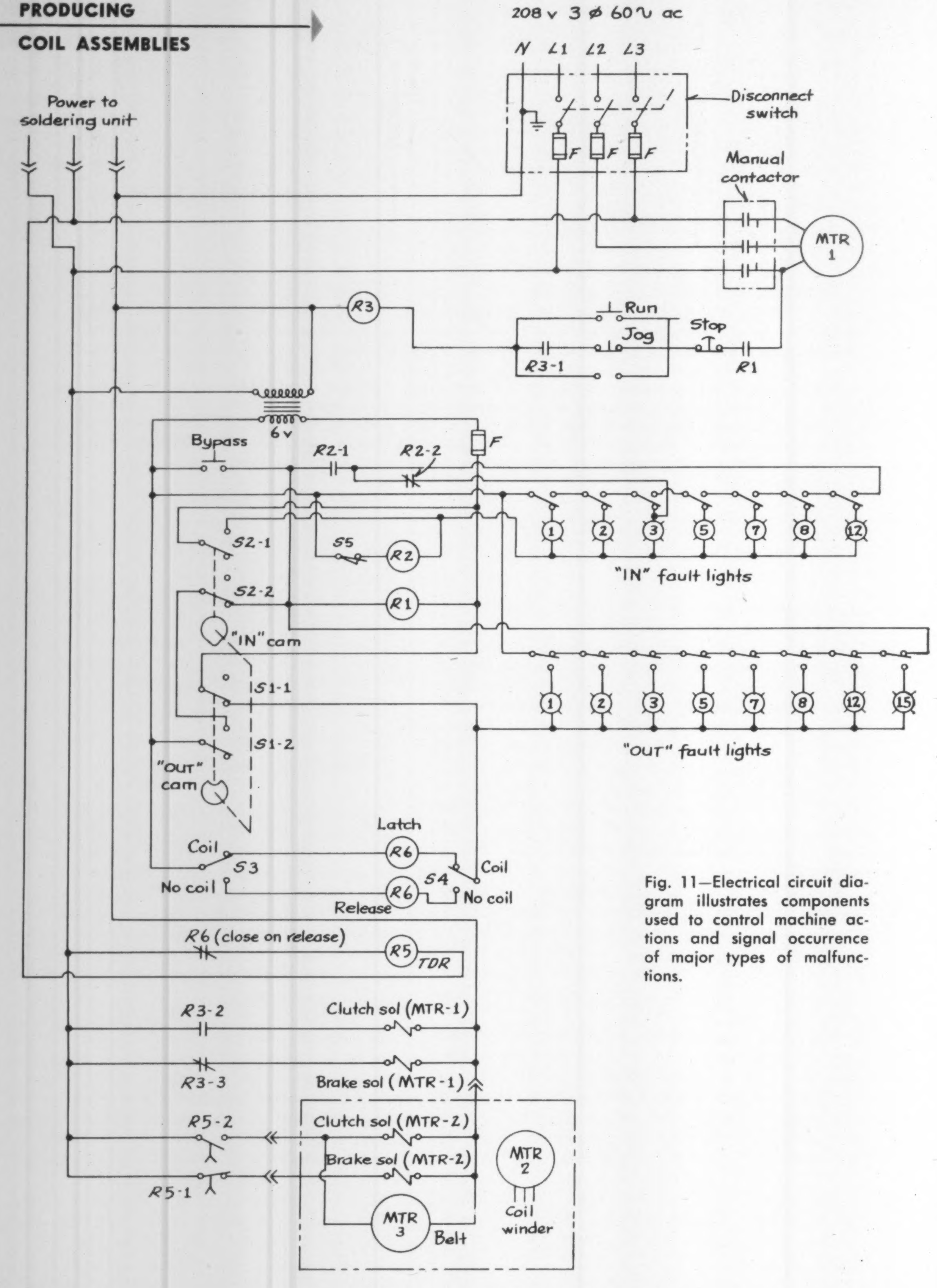
208 v 3 ø 60 ∿ ac
N L1 L2 L3
Disconnect switch
F F F
Manual contactor
MTR 1
Power to soldering unit
R3
Run
Jog
Stop
R3-1
R1
6 v
F
Bypass
R2-1
R2-2
S2-1
S5
R2
S2-2
R1
"IN" cam
1 2 3 5 7 8 12
"IN" fault lights
S1-1
S1-2
1 2 3 5 7 8 12 15
"OUT" fault lights
"OUT" cam
Latch
Coil
S3
R6
Coil
S4
No coil
R6
No coil
Release
R6 (close on release)
R5
TDR
R3-2
Clutch sol (MTR-1)
R3-3
Brake sol (MTR-1)
R5-2
Clutch sol (MTR-2)
Brake sol (MTR-2)
R5-1
MTR 2
Coil winder
MTR 3
Belt

Fig. 11—Electrical circuit diagram illustrates components used to control machine actions and signal occurrence of major types of malfunctions.

AUTOMATIC CONTROL AND FAULT-INDICATING ACTIONS

STEPS in the operation and control of the coil assembly machine can be followed by reference to the elementary diagram of *Fig.* 11.

Startup Condition. It is assumed that all of the station slides are in their fully retracted (*Out*) positions and that an insulating sleeve is positioned properly on the core assembly at Station 3. When the disconnect switch is closed, the coil of relay *R*1 is energized through the series of *Out* switches for Stations 1,2,3,5,7,8,12, and 15. These SPDT switches are held in their actuated positions by the machine slides in their retracted positions at the various stations.

When the coil of relay *R*1 is energized, contact *R*1 closes. Operation of the *Run* pushbutton will then result in energization of the coil of relay *R*3 if the 3-pole manually operated contactor for main motor *MTR*1 has been closed. Contact *R*3-1 then closes and holds this coil energized after the *Run* pushbutton is released. Contact *R*3-2 also closes to energize the clutch, and contact *R*3-3 opens to de-energize the brake solenoid and release the brake.

Indexing and Work Cycles. When motor *MTR*1 is engaged by the clutch, indexing of the worktable occurs. The slides of the various stations then advance. As the slides advance, a common shaft carrying the *In* and *Out* cams also rotates. The first result of this action is that switch *S*1 is actuated. This completes a circuit through *S*1-2 and *S*2-2 to keep the coil of relay *R*1 energized. This provision is necessary because the alternate circuit for energizing this coil—through the series of *Out* switches—is broken when the slides advance and the *Out* switches assume their unactuated positions.

When the slides reach their fully advanced positions, they actuate the *In* switches for stations 1,2,3,5,7,8, and 12. At the same time, the shaft carrying the *In* and *Out* cams rotates to a position actuating switch *S*2. Closing of *S*2-1 completes a circuit through this contact, the coil of relay *R*2, and limit switch *S*5 to energize the coil of *R*2.

Energization of the coil of relay *R*2 closes contact *R*2-1 and opens contact *R*2-2. Closing of contact *R*2-1 keeps the coil of relay *R*1 energized even though contact *S*2-2 is opened. Opening of contact *R*2-2 prevents lighting of the *In* fault light for Station 3 with the *In* switches in their actuated positions.

After the work cycle has been completed, the slides are retracted. This action continues until the *Out* cam rotates to a position allowing switch *S*1 to assume its unactuated position, when the cycle is completed. The coil of relay *R*1 is held energized during the return stroke of the slides by the circuit through the closed *S*1-2 contacts of switch *S*1 and the *S*2-2 contacts of switch *S*2, which assumes its unactuated position by rotation of the *In* cam as soon as retraction begins. Recycling is automatic, provided there is no failure of the slides to return to their fully retracted positions.

Automatic Fault Detection and Signaling. The control circuit will stop the machine and signal the station or stations at which malfunctions occur under the following circumstances:

If any slide fails to reach the fully retracted position, it will not actuate its corresponding *Out* switch, and the coil of relay *R*1 will be de-energized. Thus, the clutch for *MTR*1 will automatically be disengaged and the brake will be applied, since the coil of relay *R*3 will be de-energized. A second action will also occur—an *Out* fault light for one of the stations will go on. Assume, for example, that the slides for Stations 2 and 5 fail to return. The *Out* switches for these stations will then remain in their unactuated positions, while the switches for Stations 1,3,7,8,12, and 15 will be actuated. A circuit will be completed through *Out* switches 1 and 2, the lamp for Station 2, and *S*1-1 which is in its closed position.

The fault lamp for Station 2 will thus light, indicating failure of the slide for this station to return. When this condition has been corrected, the *Out* switch for Station 2 will be in its actuated position. The lamp for Station 2 will then go out and the lamp for Station 5 will go on. If it is necessary to jog or run the machine before a fault has been corrected, depressing the *Bypass* pushbutton and either the *Jog* or *Run* pushbutton will result in the desired action.

The function of limit switch *S*5 is to detect whether an insulating sleeve has been assembled to the core assembly at Station 3. With the slide in its fully advanced position, switch *S*5 is held closed by the sleeve. This causes energization of the coil of relay *R*2 through *S*2-1 (which is closed), the relay coil, and switch *S*5. Closing of switch *S*5 is necessary at this time to keep the coil of relay *R*1 energized; otherwise the machine will stop. If *S*5 fails to close, the *In* fault light for Station 3 will go on. The circuit for the latter action is through *S*2-1, the lamp for Station 3, contact *R*2-2, and the series of *In* switches which are in their actuated positions with the slides advanced.

If any slide fails to reach the fully advanced position when switch *S*2 is actuated by the raised portion of the *In* cam, the machine will stop and an *In* fault light will go on. In the case of the *In* fault light for Station 3 being on, the machine attendant or repairman must check to determine whether the fault is due to a missing insulating tube or failure of the slide to advance.

Coil Supply. The presence of coils in the magazine of the coil inserter at Station 5 is sensed by switches *S*3 and *S*4. One of these switches is placed near the bottom of the magazine and the other near its top. The purpose of having two switches is to ensure that a column of coils, and not a single coil in transit, will cause a control action.

The coil supply is checked each time switch *S*1 is in its unactuated position. If, at that time, switches *S*3 and *S*4 are in their unactuated positions due to a short supply of coils, the release coil of latching relay *R*6 will be energized.

Energizing of the release coil of *R*6 starts time delay relay *R*5 which is a type that delays its contact action for a predetermined time after its coil is energized. After a time delay, contact *R*5-1 opens and contact *R*5-2 closes. Opening of contact *R*5-1 releases the brake and closing of contact *R*5-2 engages the clutch for the coil winder drive. Conveyor belt motor *MTR*3 is also started when *R*5-2 closes, so that coils will be fed to the magazine at Station 5.

The coil winder produces coils at a slightly faster rate than they are used by the coil assembly machine. This is to ensure that the magazine will never be empty. The time delay preset on relay *R*5 is such that coils remaining in the magazine after a demand signal is produced can be used. This reduces the number of times the coil winder and supply belt must be started and stopped in order to maintain an adequate supply of coils in the magazine.

When the magazine is full, switches *S*3 and *S*4 are moved to their actuated positions by the column of coils. Thus, the next time switch *S*1 is allowed by the *Out* cam to assume its unactuated position, a circuit is completed through *S*1, *S*3, and *S*4 that energizes the latch coil of *R*6. This de-energizes the coil of timer *R*5, which stops the supply belt motor, disengages the coil winder clutch, and engages the coil winder brake. This condition remains until *S*1, *S*3, and *S*4 again sense a shortage of coils in the magazine.

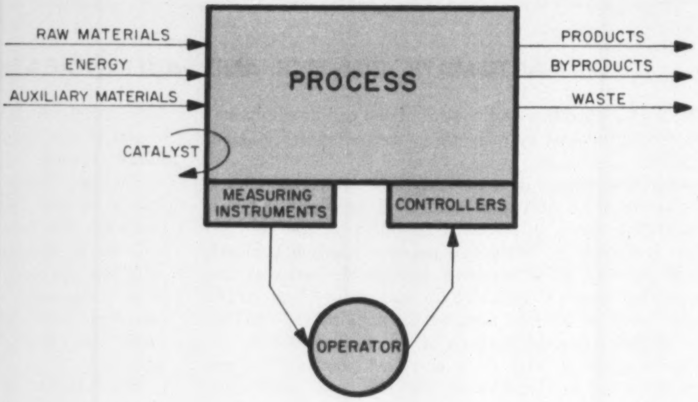

Fig. 1—Control of continuous process by human operator requires manual actuation of controllers in accordance with process variations indicated by instruments. Because of lags in operator response time, and complex relationships between controllable and uncontrollable variables, process may have to be operated at a nonoptimum "safe" level that ensures product quality.

MODERN DEVELOPMENTS IN CONTROL

Up to now there has been considerable talk about computers on the production line but little application. With intensive research, the first stages of application are now being made. What has been learned? Can we know enough about processes themselves to use computer control? What does the future promise?

By **JOSEPH F. MANILDI**, General Manager, Thompson-Ramo-Wooldridge Products Co., Los Angeles, Calif.

THE YEAR 1959 will become an important milestone in the progress of automation in the process industries. During this year a substantial number of completely automatic control systems for large-scale process units will become operative. The heart of each of these control systems will be a general purpose digital computer, specifically designed for these applications. The computer will communicate directly with process instrumentation, perform complex calculations to determine on a moment-by-moment basis the control settings for attaining optimum results, and automatically furnish signals to effect control actions.

Installations will cover a wide spectrum of industries, including chemical, petrochemical, petroleum refining, nuclear power, cement, missile, and aircraft. Large scale manufacturing units whose product value is measured in the tens of millions of dollars annually will be automatically controlled in a fashion hitherto impossible. Economic benefits resulting from this advanced control will recover the capital investment for the control equipment in as short a period as 4 months. In no case will the recovery period be longer than 2 years. These installations will provide operating proof that automatic digital control of continuous processes is not only possible, but practical and profitable.

Economics of Computer Control

Savings available from on-line continuous control by a digital computer are derived from four principal elements: 1. Increase in process through-

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put. 2. Increase in raw material yield. 3. Reduction of operating costs. 4. Better quality control.

Monetary considerations which govern the investment in a digital control system are the same as for any other capital investment—the installation must pay for itself in a sufficiently short length of time. The cost of a typical digital control system, installed complete with instrumentation, ranges between $200,000 and $400,000. A payoff period of less than 2 years is generally considered satisfactory justification for the investment required.

▶ Preliminary Study

Four years ago, our company undertook a concentrated research, development, and study effort to determine the feasibility of a line of equipment to apply digital computer techniques to the control of continuous and batch manufacturing processes. The decision to look into the possible application of digital computers to automatic control of industrial manufacturing processes was a natural outgrowth of the work which we had done with a high degree of success in the field of military digital control systems.

There is a commercial counterpart to military computer control requirements in the field of industrial process control. Typical industrial processes have to be operated in the face of continuous and uncontrollable variations in quantities which are important in their effects on the yield, on the quality of the product, on the throughput of the process, and on the cost of operating the process. Typical of these uncontrollable variables are raw material composition, raw material flow rate, ambient temperature of cooling water, and catalyst activity which changes as the quality of the catalyst deteriorates.

In order to compensate for the uncontrollable variations in these important quantities, it is necessary to make adjustments in other quantities, such as temperatures, pressures, and flow rates, which can be brought under the control of the operator, in order that specified process objectives might be attained. This is ordinarily done by operators who read measuring instruments and, with the aid of tables and charts, make what seem to be appropriate adjustments in the quantities which are under their control. This mode of operation, using the human operator to take the necessary control actions, is shown schematically in *Fig.* 1.

The problem confronting an operator in a situation of this kind is that the interactions and relationships that exist between those quantities which are out of his control, and are continually changing, and those quantities which are under his control are so complex that he cannot properly take them into account. By the time he is able to make the necessary computations, conditions have changed to the point where the results of these computations are no longer applicable. Broad operating guides, therefore, are drawn up in an effort to take into account the most obvious and significant trends in the face of changing conditions. These operating guides are designed to insure beyond any reasonable doubt that product quality, for example, is always maintained. In order to operate in this "safe" fashion, other considerations must be sacrificed. For example, the throughput of the process unit might be substantially reduced below its theoretical capability, or such operating costs as fuel consumption, material costs, cooling water costs, and catalyst costs might be substantially higher than they would be under optimum conditions. Yields and conversions might be considerably lower than necessary, with the consequent increase in costs.

A general purpose digital computer, by virtue of its stored program and its computational capabilities, can properly take into account the complex relationships between the uncontrollable and the controllable quantities in order to effect optimum operation. It is thus able to operate the process in a much more highly tuned state and, by the gains and savings effected, to justify itself on economic grounds. The process control computer must be capable of accepting process information directly from process instrumentation, making the computations required to determine the proper changes in the controllable quantities in the face of variations in uncontrollable quantities, making these calculations with the necessary speed and accuracy, and then furnishing electrical signals to make the required adjustments automatically. This mode of operation is shown schematically in *Fig.* 2.

▶ Process Unit Control

It became apparent, on further study, that one of the most promising areas for the application of automatic control techniques lay in the control of entire

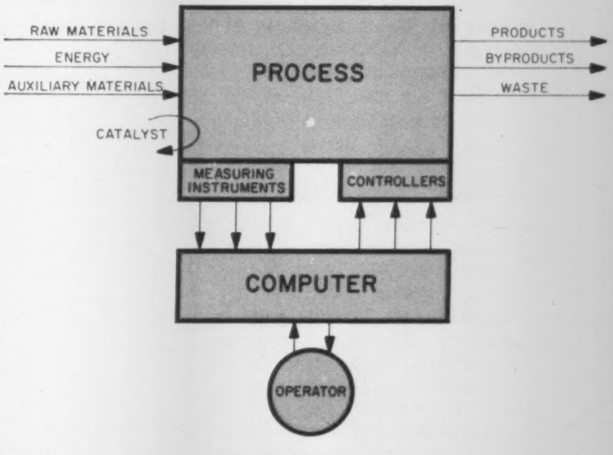


Fig. 2—Introduction of computer in continuous process control loop enables rapid, automatic adjustment of controllable quantities to provide optimum process conditions for maximum yield of good product. Computer accepts process information directly from instruments, determines proper changes in controllable quantities, and supplies electrical signals to actuate controllers.

process units, as opposed to, say, entire refineries or of smaller elements within process units. The conclusion was reached on the basis of ease of incorporating new equipment, the present state of understanding of the operation of these units, and the potential economic gain. In *Fig.* 3 and 4, for example, are shown the kinds of improvements in yield and in quality that might reasonably be expected with the introduction of techniques to automatically control complete process units.

Our studies further indicated that a digital computer, rather than an analog computer, would be better suited for the control of complete process units. The relative costs of a digital computer and an analog computer as a function of the complexity of the task which they are asked to perform are indicated in *Fig.* 5. For simple tasks requiring the handling of a small amount of information, and requiring modest computations to be performed, the analog computer appears to be more economically suited. As the complexity of the task increases, however, the increase in the cost of an analog computer is more rapid than that for a digital computer, and the latter soon becomes more economically suited. The control of single elements in a process unit can be done more cheaply by analog devices, and in fact these tasks are now being performed by analog devices such as flow controllers.

To control an entire process unit, however, and to account for all of the interactions among the various elements of the process unit, the nature of the tasks is such that the digital computer offers a substantial economic advantage. In addition, the digital computer, with its stored-program and general-purpose computational capabilities, lends itself much more readily to changes, even of a major nature, which may occur in the operation of a process or in the requirements placed upon the control function. By merely changing the program and adding, if required, necessary inputs and outputs with no replacement of existing equipment, changing requirements can be continuously met with a digital computer.

▶ Problem Areas

We often encounter areas of difficulty regarding the applicability of digital computer control techniques. These must be examined critically each time we study a process. Typically, these include:

1. The lack of analytical instruments necessary to furnish the computer with required process information. Although it is true that many of the quantities important in the operation of a process cannot be directly measured, rapid advances in the state of the art in instrumentation are expected to overcome this deficiency in the near future. Furthermore, with a digital computer control system, it is not necessary that these quantities be directly measurable. Because of the computational capability of the computer, a quantity of importance may frequently be found by making direct measurements on other quantities and then, by using either theoretical or empirically established relationships, computing the desired quantity. As an elementary example, a gas density may be determined by measuring the temperature and pressure of the gas and by computing the density through the use of either appropriate gas law equations or empirically determined gas tables stored in the computer's memory.

2. The lack of understanding of the process itself. This situation exists and will continue to exist as long as new processes are being developed. One must, however, face up to the fact that these processes are being and will continue to be operated. Sufficient information is now available to operate them with acceptable effectiveness, even though they may not be operated in the best possible fashion. They can be operated more efficiently by applying control techniques based on the present state of understanding and on the operating data which are available, or can be made available, by studying the process carefully. In this regard, the control computer can perform an additional function of logging and analyzing the data continuously as it becomes available. Correlation techniques can be used on operating data to formulate acceptable and usable models. On the basis of these models, the proper control functions can be performed in the absence of a complete theoretical understanding of the process.

3. The necessity for reliability. The application of digital computers to process control demands an exceedingly high degree of reliability before it can be considered. This is in contrast to the use of digital computers for scientific and

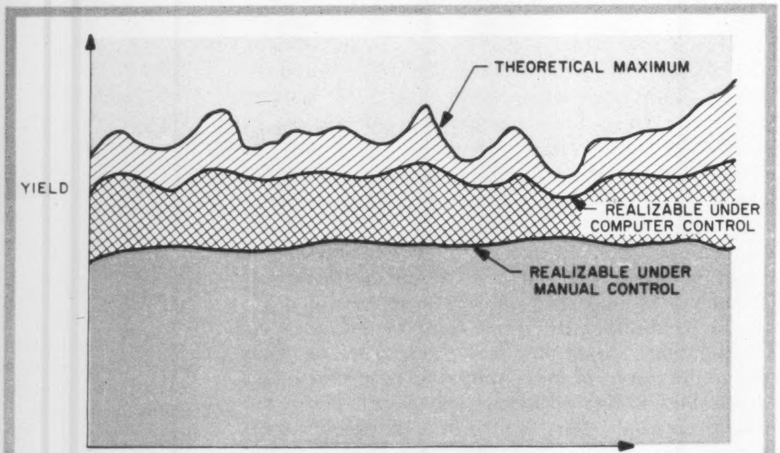


Fig. 3—Curves illustrate gains in product yield obtainable by substituting computer for manual control of continuous process. Yield under computer control is higher than that for manual control, and more faithfully follows peaks and valleys in curve of maximum theoretical yield.

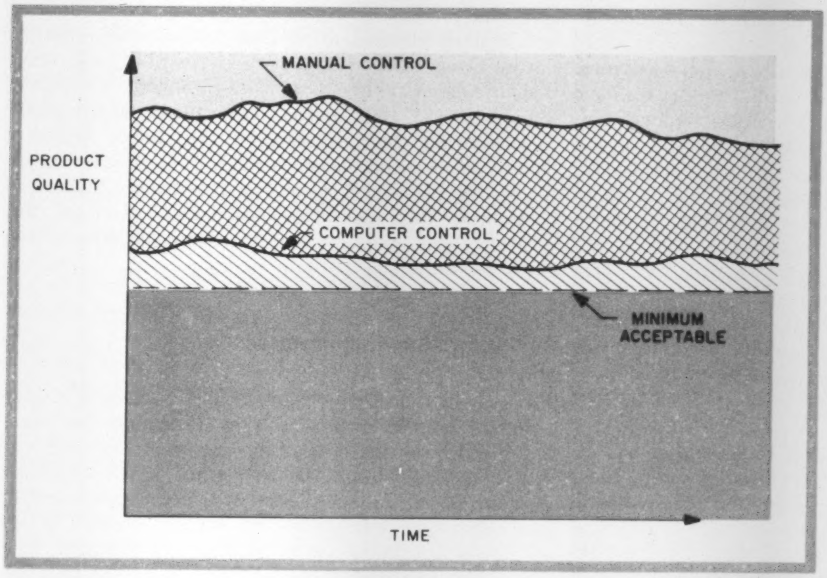


Fig. 4—Product quality can be held closer to minimum acceptable value with computer control than with manual control of process. This minimizes amount of product having unnecessarily high quality with resultant increase in costs.

business computation where breakdown of equipment, although perhaps distressing and inconvenient, can be tolerated. Typical reliability figures of 80 or 85 per cent presently attainable with high-speed scientific computers would be unacceptable for industrial process control. The reliability factor must be higher than 99 per cent for a process control computer. In addition, the turn-around time, when failures do occur, must be exceedingly short. Maintenance and repair must therefore be accomplished simply, rapidly, with readily available equipment, and in the field. Even so, the process unit must continue operating during the relatively short repair time, since process shutdown and startup are expensive, time-consuming procedures. These requirements can be met by an extremely reliable digital computer, taking advantage of recent advances in the use of solid state components (i.e., transistors and semiconductor diodes) and in advanced electronics packaging techniques. Simplicity in logical design is equally important. Continuous operation of the process itself can be assured by having the computer adjust the set points of conventional controllers and by having the set points either remain at their last established value or return automatically to a predetermined value in the event of computer failure.

▶ Computer Design

Studies of a number of different processes established the performance requirements for a process control computer. A medium speed computer was indicated, since typical process changes of a significant nature occur at intervals which do not require the computing speeds of large scale scientific computers or of airborne flight and fire control computers, but instead roughly one-tenth these speeds. This feature permits simplicity in design, with attendant ease of maintenance and increase in reliability. Furthermore, the nature of the computations and the accuracy required in typical industrial process control applications are such that the precision of the computer need not be as great as that of a large-scale scientific computer. A word length (number of digits in each piece of stored data) approximately half that used in a scientific computer is quite satisfactory for a process control computer. Associated with the shorter word length is the advantage of an increase in word storage capacity for a memory unit of given physical size.

▶ Development and Evaluation Programs

The basic studies discussed previously led to the decision to initiate the development program to bring this equipment on the market. An evaluation program, proceeding in parallel, was also initiated. The necessity was recognized for coming to grips with specific potential applications for this equipment, so that technical and economic evaluations could be applied to a number of actual processes in the process industries. It was assumed that the research and development problems that would be encountered would be satisfactorily overcome and that, between 12 and 18 months after the start of the program, hardware would become available incorporating the performance characteristics which had been set down.

In order to put this technology and the not-yet-existent equipment to test, a few companies were approached with the suggestion that forces be joined in making detailed technical and economic studies of one process from each. The specific purpose of this arrangement was to determine whether their processes would lend themselves to digital computer control techniques. These studies were begun as early as 1956. Many have now been completed, all with highly encouraging results. These studies have shown that the tangible benefits to be gained will pay off the investments in computer control systems within periods ranging from 4 months to 2 years. A number of installations, to be completed this year, are under way in the chemical manufacturing, petroleum, nuclear power, cement, and aircraft industries.

These joint studies, carried out by Thompson-Ramo-Wooldridge Products Co. engineers in close co-operation with the engineers of the companies for which the studies were being conducted, have resulted in many important benefits: 1. Information leading to a more thorough understanding of the process under study. 2. Evaluation of the application of computer control techniques not only to those processes under study but also to similar processes within the industry and in other industries. 3. Acquaintance of our engineers with the everyday problems of operating large process units, and simultaneously, acquaintance of the engineers of the participating companies with the capabilities of this new technology, permitting them to make their own independent evaluation of how this technology may lead to increased profit.

Information gathered during these studies has already resulted—through good feedback of information from the engineers conducting the studies to those designing the equipment—in modifications of the equipment to make it better suited for the tasks at hand. Other new and previously unsuspected areas of application have come to light as a result of these studies. One of these areas has to do with the automatic control of testing operations. The use of a computer control system here can effect substantial savings in time, and therefore costs, as well as providing data in analyzed form which are immediately useful.

▶ Selecting a Process

Detailed studies are an integral and necessary part of each system installation. The first step in initiating such a study is to select a process. This selection must be made both on technical and on economic grounds. From the technical standpoint there must be a certain minimum understanding of the process itself. As mentioned before, this need not be a complete theoretical understanding, but it does require that sufficient data on past operating performance are available so that, in the absence of theoretical understanding, empirical relationships can be determined. On the basis of these, the control functions can be established, and a valid estimate of the expected gain can be made.

The economic criteria for the selection of a process for study can be set forth rather simply. The cost of a typical control system might amount roughly to $250,000. Such a system could include a digital control computer; the associated analog-to-digital and digital-to-analog conversion equipment (which permits the system to accept information directly from the process and to furnish analog signals for controlling the process); the added instrumentation which may be required to fully take advantage of the capabilities of the digital control system; and the engineering required to design and install the system, program the computer, and assure the proper operation of the system. It is obvious, therefore, that in selecting a process for study, one would not select a process where the total annual value of the product is a few hundred thousand dollars.

Studies conducted to date indicate that digital control systems, when properly applied, can lead to increased profits ranging from 4 per cent to perhaps 20 per cent of the value added to the product during the processing. If the lower figure is used as a conservative estimate, and if an acceptable payoff period of not greater than 2 years is selected, then the necessary added value of the throughput must be of the order of $3 million per year.

▶ System Requirements

Having selected a process that seems appropriate for study, the next step is to determine the functions to be performed by the computer control system. In addition to the control function, which is the basic function that it will perform, a number of other useful functions can be performed. One of these is the logging of data; either raw data, if that is desirable, or data which have been analyzed by the computer and reduced to a form which is more useful to a better understanding of the process. The computer can also perform certain checking functions to ensure that the process instruments and the process itself are functioning properly. These checking functions also include self-checking, during which the computer gives itself tests and then compares the answers with known answers stored in its memory in order to detect any malfunction. In addition, provision for printing out or otherwise signaling an alarm can frequently be valuable in preventing serious plant upsets.

During the study a careful analysis is made of the instrumentation problem associated with improving the process and taking full advantage of

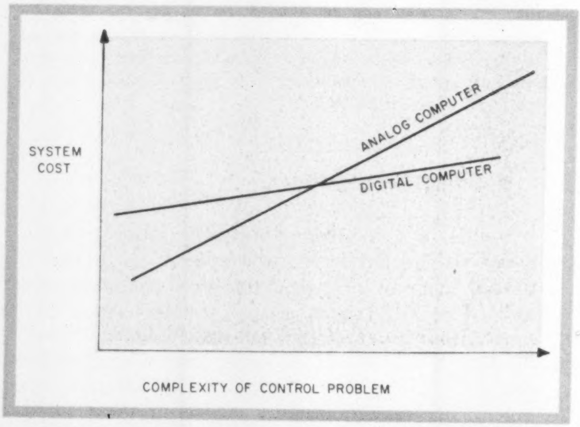


Fig. 5—Complexity of control problem determines economic choice between analog and digital computer for continuous process control. Use of analog computer is indicated when small amounts of information requiring relatively simple computations are involved. Digital computer is more economical for control of complete process units in which interactions among variables are complex.

the computer control capabilities. This entails, among other things, being completely informed on new instrumentation which may be available to the process industries.

A very important phase of the study, of course, is that of establishing the relationships among the important variables, which may be either controllable or uncontrollable. The former will be controlled to compensate for the uncontrolled variations in the latter in order to attain a specified set of process objectives. This phase of the study also includes a critical analysis of a number of possible objectives, which may vary as market conditions vary or as the objectives of other process units associated with the unit under study vary.

A further requirement is to study the dynamics of the process. Although a computer control system as proposed does not look after the dynamics of the process, since dynamics are handled by the individual loop controllers which the computer control system supervises, it is nevertheless necessary to assure that no upset occurs if the computer-controller takes too rapid action. If such a danger exists, the computer can be programmed to take the control actions at a rate which would not cause any danger of upset.

Another important consideration in the study is that of assuring that a computer control system would always be fail-safe. Even though computer reliability may be 99.99 per cent, there must be absolutely no risk that a major plant upset could occur at any time. All possible conditions of control system failure need to be examined and proper precautions taken to assure that in any of these contingencies the process would continue to operate and that it would continue to operate safely.

The final phases of the study are concerned with making an estimate of the cost of equipment to exercise computer control on the process and a careful study and estimate of the potential payoff that might be realized by using a computer control system.

▶ Typical Controlled Process

These remarks may be more meaningful in light of a simplified discussion of a typical process which has been found to lend itself to a digital computer control system. In this process the end product has two quality criteria which must be very carefully met. Although it is acceptable, albeit expensive, to produce material in which these two quality measures exceed the acceptable minima, it is not acceptable to produce material in which either of these quality criteria is less than the acceptable minimum, since the product then will not have a market. This situation may be depicted graphically, as two straight intersecting lines, *A* and *B,* in *Fig.* 6. Yield is shown as the ordinate, and raw material feed rate as the abscissa. Operation below line *A* assures that quality *A* is acceptable, and operation above line *B* assures that quality *B* is acceptable. On this diagram are also shown lines of constant profit, these being based on the value of the end product, the cost of the raw materials, and the costs of operating the process.

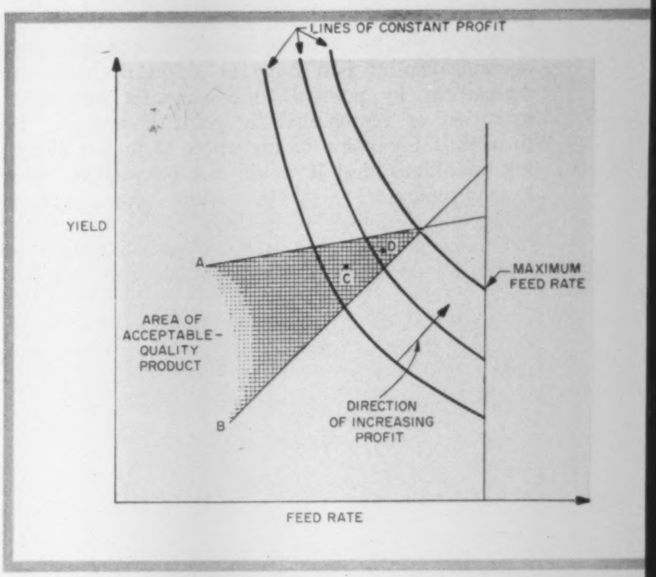


Fig. 6—Plot of product yield versus raw material feed rate illustrates advantage of computer control of continuous process. Operation must be confined to shaded area to meet product quality criteria. Point of optimum operation is at intersection of lines *A* and *B*. With manual control of process, operation in the vicinity of point C is possible. Computer control automatically maintains operation at point *D*, with resulting greater profit.

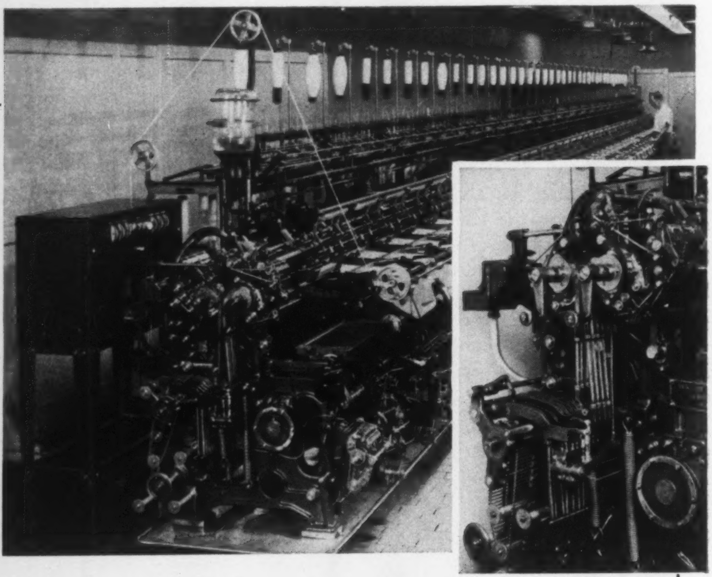
It becomes apparent from the diagram that the point of optimum process operation is at the point of intersection of the two lines of minimum acceptable quality. However, because of the inability of the human operator to take proper control action in the face of, say, changing composition of the incoming raw material and to make appropriate changes in, say, temperatures, required to keep the proper value of yield, he will need to operate the process at a sufficiently safe point, say, at point *C*. This will ensure that both minimum quality specifications will be met.

A computer control system may not be able to react to all conditions so as to keep the process operating at the intersection of lines *A* and *B*. Changes in these conditions may not be thoroughly understood or may have a statistical distribution within which random fluctuations can be expected. It can, nevertheless, through its powerful computational capabilities, operate the process at, say, point *D*. The distance *CD* is a measure of the gain attributable to the computer control system. Furthermore, straight lines *A* and *B*, depicting the acceptable operating regions for the process, may themselves change in position and slope with time as a result of other variations occurring in the process unit. Under these conditions, it is important for the computer to operate as closely as possible to the intersection of the two quality lines. Whereas a human operator can at best hope to attain operation as represented by point *C*, the computer can effect operation as represented by point *D* and can in turn shift the point of operation *D* under changing conditions that it would not be possible for a human operator to follow without serious risk of going "out of bounds" on quality.

One might also note in this application that the closer the slopes of these quality lines approach one another, the smaller becomes the acceptable region of operation and the greater is the loss entailed through "safe" operation by a human operator. Conversely, the greater is the potential gain that might be obtained by a computer control system.

▶ Systems Approach Essential

Accomplishments of the kind mentioned are made possible by a careful and detailed systems approach. A close and effective working relationship between the user and supplier of equipment is essential. Study teams comprising the talents of chemical engineers, petroleum engineers, physicists, electrical engineers, and mathematicians establish the basis for proper application of digital computer control and formulation of the mathematical models which determine the control actions. Only an integrated approach of this kind can ensure properly identifying, analyzing, and evaluating the benefits. There is no other way of assuring that the technological advance in control is real and not just an apparent one.



MULTIHEAD KNITTER PROGRAMMED MECHANICALLY

DESIGN refinements applied continually over a period of several centuries have brought modern textile knitting machines to their present high degree of maturity. As a result, these machines are capable of dependable, continuous automatic operation, with life expectancy of two or three decades.

Evidence of the rugged, simple design of this class of equipment is found in the Reading Type 60 full-fashioned hosiery knitting machine recently introduced by Textile Machine Works. Each of the 38 workheads of this machine simultaneously produces a hosiery fabric by forming a series of interlocked loops from a single, 0.002-inch thread.

The actual knitting operation performed in each workhead is done by an assembly that includes flexible needles working in conjunction with flat blade members called sinkers, dividers, and knockover bits. The complex, interrelated actions of these elements are synchronized to produce the fabric one course at a time. Other functions performed automatically in each workhead include contouring the fabric at its width (called narrowing), and forming of a double-thickness reinforcing welt at one end of each product unit.

An example of mature mechanical design is found in the programming mechanisms for the machine. Five continuous chains composed of wire links, of the type shown in the close-up, are used at various places on the machine. Each chain is indexed periodically by a ratchet. As a chain is indexed, successive links are positioned in turn under a group of control levers placed side by side across the width of the chain.

In programming the machine, steel buttons are fitted to preselected links of each chain. Chains that can accept 6, 12, or 14 buttons across each link (depending upon the number of control levers to be actuated) are used. When a given link is in position under a group of control levers, each lever will either be lifted by a button or remain in its unactuated position because a button is not present. In this manner, the machine can be programmed to synchronize all of the machine actions necessary to produce any of a variety of product types and sizes.

JOB SHOP AUTOMATES DEBURRING AND TURNING

SUPPLIERS sometimes find themselves in direct competition with customers who are simultaneously manufacturing the same types of products in their own well-equipped shops. Success of these suppliers may then depend heavily upon whether they can equal or better the customers' output rates and production costs for the same items. In such cases, automation of the suppliers' operations may be a virtual necessity.

Two examples of automation applied by Borg & Beck Div., Borg-Warner Corp., illustrate some of the measures this supplier has taken to improve the manufacture of automotive transmission stator assemblies. The stator assembly includes a multivaned aluminum stator with a concave steel band around its circumference.

In the first of the automated setups, *Fig.* 1, it is necessary to remove the fine burrs left in machining the OD of the vanes. This is accomplished by blasting the parts with ground apricot pits as they are rotated in a cabinet.

Machined stators are introduced to the setup via an inclined track. As they roll down the track, they arrive in turn at a loading station in front of the blasting cabinet. Each part entering the loading station actuates a limit switch. This causes a pneumatically operated plunger to pick up the part in the station and advance it into the cabinet. When the part is fully advanced, a rotating shaft entering the cabinet from the rear engages and slowly turns the stator. A timer is also energized that activates four nozzles to blast the rotating parts for a predetermined time.

When the timer runs out, the nozzles are deactivated and the plunger and part are retracted. When retraction is completed, the deburred part is automatically released into a discharge chute and delivered to the next operation. As soon as the loading station is cleared, another rough part rolls into position and the cycle repeats. One complete cycle occurs every 18 seconds.

Deburred stators are subsequently sent to a workstation where each one receives a concave shroud band around its circumference. The ends of the bands are joined by a manual welding operation. When welding is completed, each part is placed in a chute leading to the spindle of a modified Jones & Lamson Machine Co. lathe, *Fig.* 2. In this second automated setup, the leading part in the chute rolls to a stop with its axis in line with that of the lathe spindle. The tailstock then advances, centering and clamping the part in the machining position.

With the spindle rotating, the lathe slides are next activated to advance two cutting tools against opposite edges of the shroud band. Two cuts—rough and finish—are taken. The tools then retract and the slides move away from the cutting area to provide clearance for the finished part to be ejected.

Release of a part from the spindle is effected by retraction of the lathe tailstock. This frees the part so that it can roll down an unloading chute at the front of the lathe. In moving down the chute, the part passes under a gage that automatically checks its OD. Tolerance on this dimension is 0.004 inch. If the turned diameter exceeds the maximum limit, the part is stopped at the gage and the machine is shut down. In normal use, the setup operates automatically except for tool resetting. A supervisor makes occasional observations to see that the system is functioning properly.

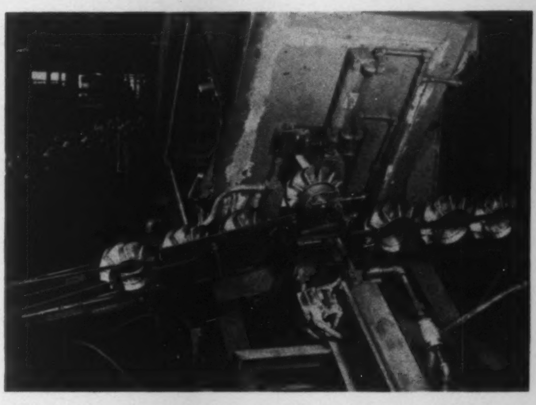


Fig. 1—Fine burrs left in machining OD of aluminum stators are removed in blasting cabinet. Loading and unloading of parts, and timing of blast, are automatic.

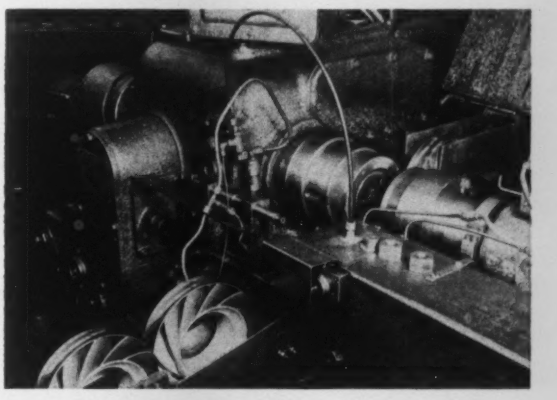
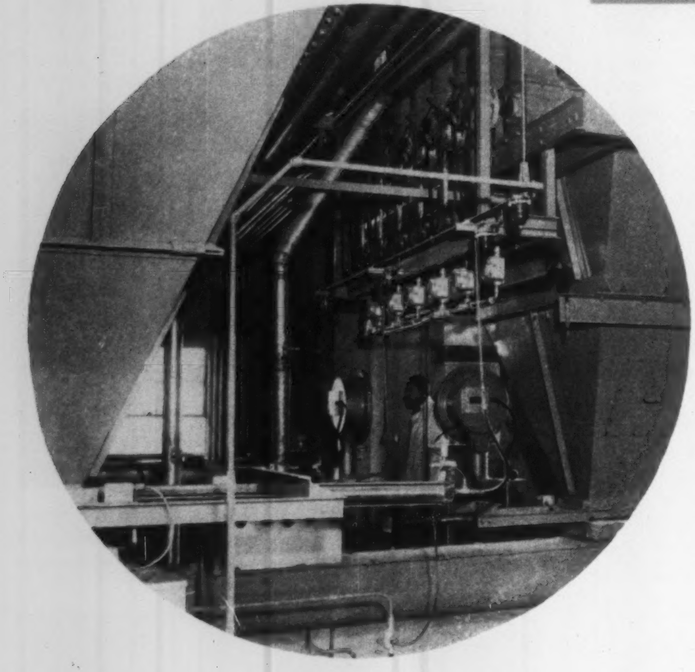


Fig. 2—Edges of steel shroud bands assembled to stators are turned in automatic lathe. Parts are automatically loaded, unloaded, and gaged for turned diameter. Machine shuts down when diameter exceeds upper limit.

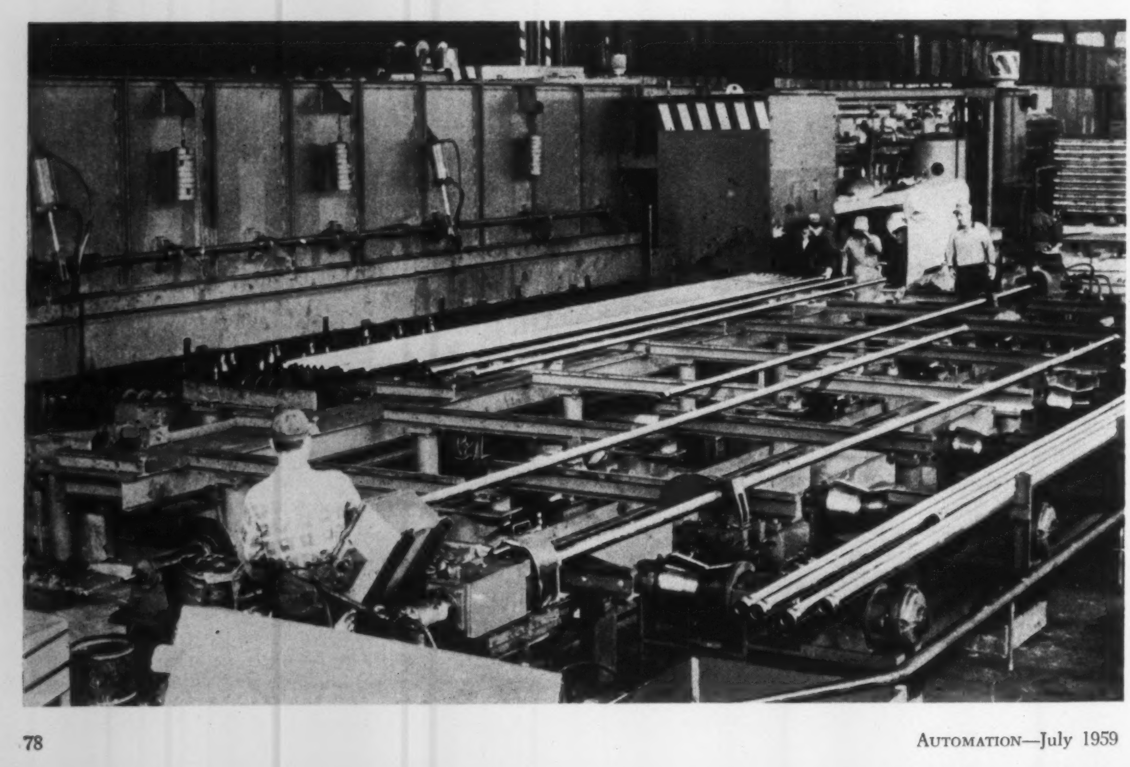


Feed Blending

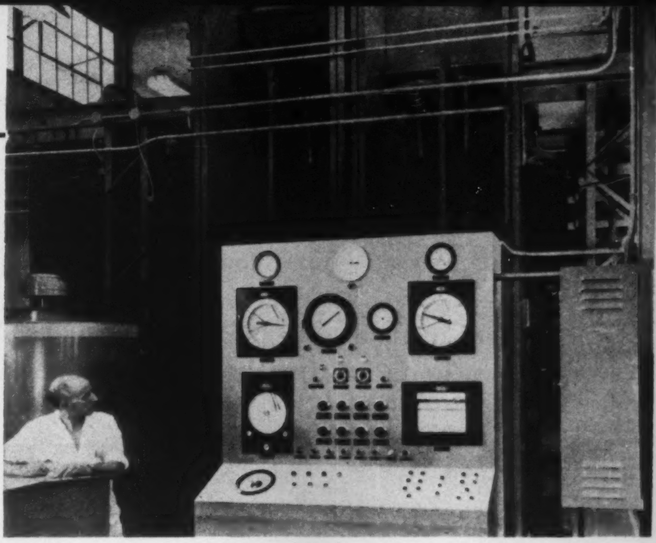
BULK materials handling system at Faultless Milling, coupled with new blending and storage facilities, has doubled mill capacity and reduced production costs in turning out concentrated formula farm feeds. Pneumatic systems transfer ingredients from railroad cars and trucks to 45 storage bins located in a tower. In batching and mixing operations, feed is moved from selected storage bins to scale hoppers under control from a central panel. Scale hopper room, shown in photograph, contains 10,000 lb automatic scale for major ingredients and a 500 lb scale for premixes and materials used in small quantities. From scale hoppers, materials are dumped into a mixer and subsequently transferred to other areas for further processing or packaging. The pneumatic systems were provided by the Fuller Co.

Pressure Testing

FACILITIES for hydrostatic testing steel pipe at pressures of from 700 to 15,000 psi have been installed at the Ambridge plant, Tubular Div., National Supply Co. System includes equipment for blowing out scale and dirt, stenciling information on pipe, screwing on couplings, delivering pipe to the hydrostatic tester, completing the test, weighing pipe after testing, screwing on thread protectors, and spraying each length of pipe with oil. The outlet side of the hydrostatic testing machine, where thread protectors are automatically screwed in place, is shown. As many as 240 pieces of 35 foot long pipe can be processed in an hour.

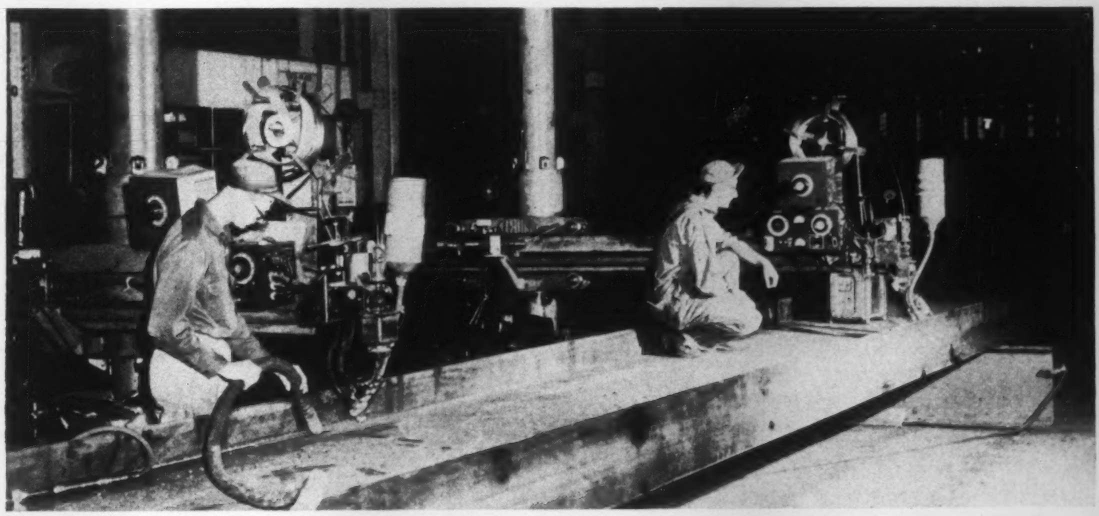


in action



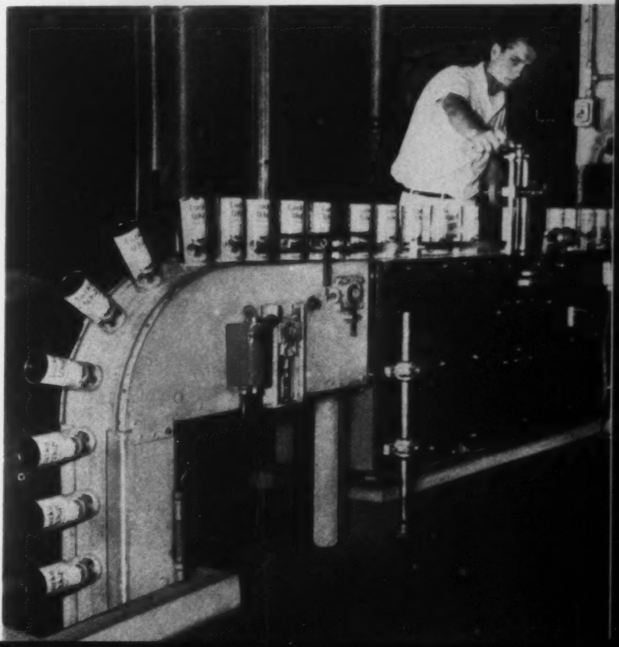
Lamination Press Control

CONSOLE at Arborite Co. Ltd., Montreal, controls multiplaten press. Instrumentation furnished by Minneapolis-Honeywell Regulator Co. provides centralized control of the press. Pushbutton operation begins a controlled cycle in the laminated plastic production process that includes heating, curing, and cooling.



Girder Welding

INCREASED requirements for fabricated structural steel girders has led R. C. Mahon Co. to search for more efficient production techniques. To produce welded girders, the company has established a production system that teams up overhead cranes, special universal splicing and tacking fixtures, and semiautomatic and automatic submerged arc welding machines. Picture illustrates use of two automatic Lincoln submerged arc welders to form continuous fillet welds in joining the two flanges to a web. The welders travel along the side of the work on a common track at the rate of 25 inches per minute. The work is reversed by crane to weld the opposite side of the girder.



Magnetic Handling

EMPTY metal containers are transferred from an upper to a lower floor in a Lever Brothers' plant by a conveyor belt riding on magnetic rails. The units are transferred from a coding machine (shown) to a filling machine located on the lower floor. Built by General Conveyor Co. Inc., the conveyor consists of a 7-inch wide neoprene impregnated belt that moves on a slider bed made of Eriez Mfg. Co.'s magnetic rail units. Channels on either side of the belt confine the belt against the rails. The magnetic action holds the cans securely in place when starting and stopping the line, and during processing at a speed of 90 cans per minute.

Electrohydraulic servo valve systems provide a convenient means for linking electronic control to hydraulic power for fast and precise closed loop control of machine element position, speed, and acceleration. The development of electrohydraulics, basic methods of applying electrohydraulic systems, and application limitations are discussed in this article.

ELECTROHYDRAULIC SERVO VALVE SYSTEMS

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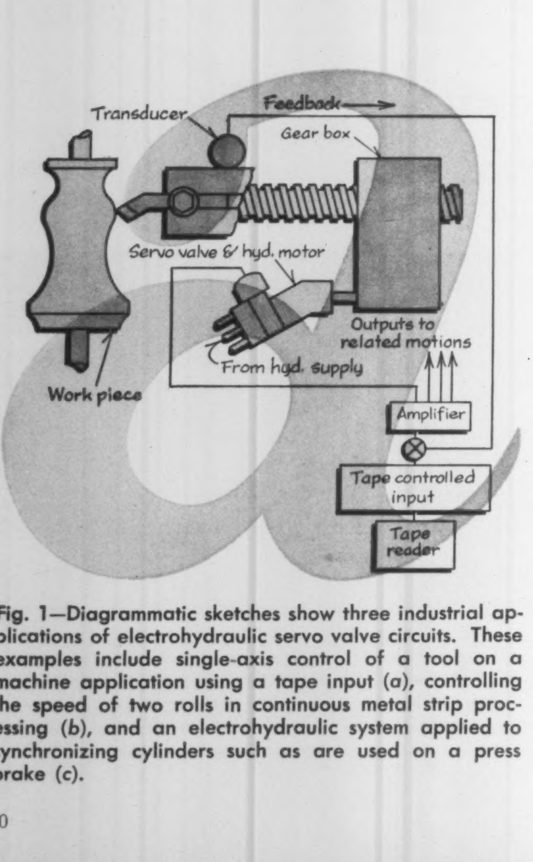
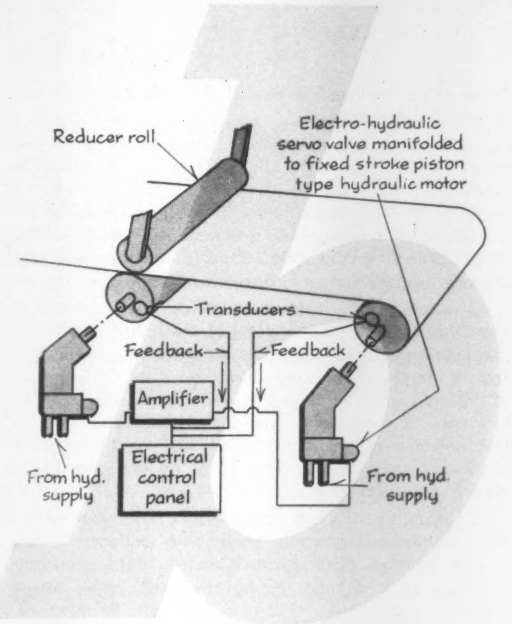


Fig. 1—Diagrammatic sketches show three industrial applications of electrohydraulic servo valve circuits. These examples include single-axis control of a tool on a machine application using a tape input (*a*), controlling the speed of two rolls in continuous metal strip processing (*b*), and an electrohydraulic system applied to synchronizing cylinders such as are used on a press brake (*c*).

DEFINITE limits to man's ability to continually concentrate on his work, respond to changing operating conditions, and apply fast and accurate corrective action have been recognized since the beginning of the industrial revolution in 1760. To reduce the effect of these shortcomings, many mechanical and electrical devices have been added to machines over the intervening years to control their operations. Although these devices have added speed to some operations and have allowed the machine operators to concentrate mainly on accuracy considerations, the skill and judgment of man is still required to set up the machine and to make corrections for varying conditions.

Within the last decade many new and outstanding developments in the fields of electronics and hydraulics have provided a completely new outlook in methods to automatically program and control machine tools, production machines, and fabricating and processing equipment. These methods have relieved the machine operators of routine skill and judgment considerations in the operation of single machines and have elevated the operators to positions of supervisory control over multiple machine installations. Today, programmed machine operating data on punched cards, punched tape, or magnetic tape can be fed directly into a machine control system, electronically translated into command


Reducer roll
Electro-hydraulic servo valve manifolded to fixed stroke piston type hydraulic motor
Transducers
Feedback
Feedback
Amplifier
Electrical control panel
From hyd. supply
From hyd. supply

signals, and transmitted to control elements such as electrohydraulic servo valves. These valves convert the electrical signals into extremely accurate, modulated flow of hydraulic power for fast and precise control of position, velocity, and acceleration.

Not only can speed of operation be gained in this manner, but, by using a closed loop system, the machine action can be continuously monitored by electrical feedback devices to ensure that the programmed directions are being accurately followed. The advantages of this type of control are immediately obvious—faster operation, reduced error, increased accuracy, improved part duplication, less inspection required, easier component assembly due to more closely controlled tolerances. Several diagrammatic circuits for industrial applications of electrohydraulic servo valves are shown in *Fig.* 1.

▶ Development of Electrohydraulics

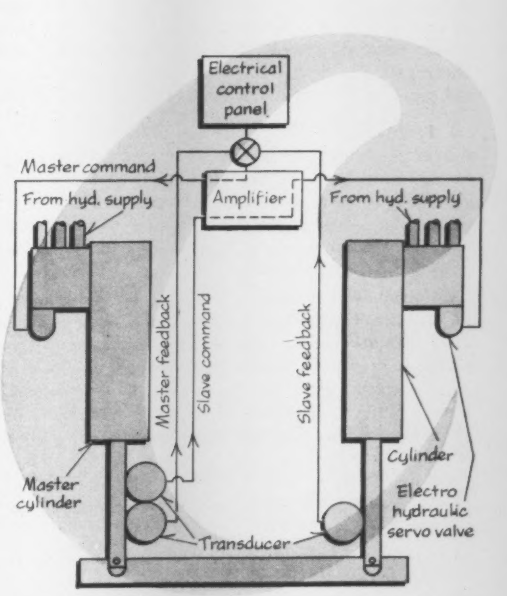
A significant step forward in control of hydraulics was made some 30 years ago when solenoids were added to valves. This allowed flexibility in sequencing and controlling the direction of hydraulic power, but direction alone was not enough. In many applications velocity, position, and/or other characteristics of the actuator had to be controlled. This need led to the development of electrohydraulic servo valves.

Although much of the early work in servos was done with instrument-type electrical servos, the need for large power outputs in small packages put the spotlight on electrohydraulics. The small size of the hydraulic actuators and servo valves was beneficial not only because they could be squeezed into a small area, but because the high torque output, combined with the small inertia of the hydraulic motor's rotating group, allowed very good dynamic control.

World War II spurred the development of electrohydraulics, and experience obtained in the military field was utilized to advance industrial application techniques. However, it should be noted that there are distinct differences between military servo systems and those used for industrial machine tool and processing applications. For example, in the military, greater than normal routine maintenance is employed, clean operating conditions are usually found, and spare units are readily available. This is not usually the case in industrial applications. Although attempts are made at cleanliness and preventive maintenance, the equipment used in industrial systems must be capable of long life, ruggedness, and compatibility with varying dirt conditions.

On the other side of the scale—counterbalancing long life, ruggedness, and dirt compatibility—are requirements for high response and sensitivity. Some of these requirements, such as ruggedness with sensitivity, many seem to contradict each other, but careful engineering is solving these problems.

In order to obtain the maximum advantage from standard electrohydraulic components, each part of the system must be carefully selected and analyzed. This will assure optimum performance of the overall system. Experience to date has established certain rule-of-thumb methods in applying electrohydraulic equipment to the best advantage. Basically, there are two methods of using an electrohydraulic servo valve to provide a link between an electronic control system and a machine. The most frequently


Electrical control panel
Master command
From hyd. supply
Amplifier
From hyd. supply
Master feedback
Slave command
Slave feedback
Cylinder
Master cylinder
Electro hydraulic servo valve
Transducer

FACTORS IN APPLYING SERVO VALVES

ELECTROHYDRAULIC servo valves are in a transition period. Their successes achieved in military and machine tool applications have demonstrated their great value in industrial control systems. To apply servo valves, the manufacturing engineer should become familiar with their functions, capabilities, reliabilities, economics, and special application considerations. These factors are quite interrelated, and it is the over-all evaluation of these factors that determines the suitability of using servo valves.

Function. The electrohydraulic servo valve is simply a directional flow control valve. With all other conditions fixed, the servo valve output flow is essentially linear with its electrical input. The electrical device that receives this electrical input is called a torque motor, and the torque created by this device is proportional to the dc current applied to it. Most configurations of torque motors have a torsion spring. The distance moved by the armature shaft of the torque motor at any given instant is the resultant of the torque due to the input current and the spring rate of the torsion spring. Therefore, if a valve spool is connected to the torque motor, its linear movement will be proportional to the electrical input.

Capabilities. There are many aspects of servo valve capability. First, there are the static characteristics such as maximum flow and operating pressure. These are important to meet the basic requirements of the application. Second, since most applications are servo, or feedback control systems, the engineer should also be concerned with the dynamics or ability of the servo valve to respond quickly and accurately to rapid changes in the electrical input signal. In a closed loop system, the output of the system is continuously monitored and compared with the reference input signal of the system. Should there be a difference in reference and output signals, a correction is instantaneously signaled to the servo valve. If the servo valve is slow in responding or is highly insensitive to small corrective signals, the over-all system will be less accurate and may break into uncontrollable oscillations. The capabilities of a servo valve are determined by flow and pressure, resolution, linearity, response, and reliability.

1. *Flow and Pressure.* It is not uncommon for an industrial application to require an output flow of 10 gallons per minute, or better, with supply pressures of 1000 psi or less. This is readily achieved with some servo valves. In other applications, it may be necessary to use supply pressures of 3000 psi to provide sufficient acceleration for larger loads.

2. *Resolution.* A servo valve must be highly sensitive to very small corrective signals. For example, in some cases the maximum torque available for a torque motor results in a 5-pound force being transmitted linearly to a valve spool. It is not an uncommon requirement for a servo valve to respond to 1/100 or 1/500 of the maximum force. This indicates the extreme sensitivity of the servo valve. The quantity of sensitivity is called the deadband or threshold, and it must be considered from two points of view—component and system. System deadband reflects friction, leakage, and backlash in the system. Servo valve deadband is one of the contributing factors of system inaccuracy.

3. *Linearity.* It is desirable to have most of the control range of the servo valve linear; that is, for all other conditions being equal, the output flow would be proportional to the current fed to the servo valve torque motor. For example, in a machine tool multiaxis contouring application, each axis must be cutting at its prescribed rate. If linearity does not exist, inaccurate cuts may result.

4. *Response.* The servo valve should not contribute to any large extent to the slowness of the system. However, the response in each system is different. A system having a large mass may have a natural frequency of ½ cps, and one having a very small mass may be 100 cps. A servo valve would contribute very little to the slowness of the first system and might be quite significant, or even a limiting factor, in the speed of response of the 100 cps system.

5. *Reliability.* If high production rates are to be achieved, downtime due to servo valve malfunction cannot be tolerated. The engineer should look beyond performance in selecting a servo valve. The valve should not be supersensitive to dirt, temperature, or other environmental conditions. Simplicity of design is one indication that a servo valve will be relatively trouble free.

Special Considerations. The effect of dirt, heat, and dither should be considered when using servo valves. Experience has shown that a good servo valve will operate satisfactorily with 10 micron filtration. However, before any system is used, it should be thoroughly flushed to rid it of all possible traces of dirt. Some extensive systems may take as long as a month for thorough flushing, but most systems should require only a couple of days. If all the dirt is removed from the system in the beginning, normal filtration should keep the operation trouble free for long periods of time.

Heat problems are readily solved with proper cooling techniques, using either air or water. Consideration should be given to the hydraulic power supply for the system since constant input pressure must be available at the servo valve. The heat problem in this part of the circuit can be attacked by substituting pressure compensated pumps and accumulator unloading techniques. Since a servo valve is only two-thirds efficient and the horsepower loss is converted to heat, higher input horsepowers are required in a servo valve system than in other systems. This is the price that must be paid for the better system performance obtained with the servo valve.

Since the servo valve must be sensitive to small signals, dither is used to reduce the force that the torque motor must overcome. Dither is an ac signal superimposed on the dc control signal which reduces the effect of static friction of the valve.

Economics. The price of the electrohydraulic servo valve should not be compared with that of a simple on/off type valve since the servo provides much more in the way of flexibility of fine control. A good industrial servo valve can be described as a rugged instrument. As such, it costs more to manufacture than other type valves. However, the ultimate goal of a servo valve is to save money when properly applied. As engineers become more familiar with the servo valve, it will be as readily applied as are relief valves and check valves.

used method is the valve-motor system, but a second method, the servo pump system, can be used to advantage in some situations.

▶ Valve-Motor Systems

A pictorial diagram of a valve-motor circuit is shown in *Fig. 2.* The servo valve is used to directly control the flow of oil into and out of the hydraulic motor. When manifolded directly to the motor, the servo valve provides a tight, closely-coupled system with a minimum of oil under compression. A formula for deriving an indication of the frequency response of the valve to the motor in such an arrangement is

$$F_n = \frac{D_m}{2\pi}\sqrt{\frac{2}{VEJ}}$$

where F_n is the frequency response, cps; D_m is the displacement of the hydraulic motor, in^3/rev; V is the volume of oil under compression, in^3; E is the compressibility factor of the oil, in^2/lb; and J is the inertia of the load, lb-in sec^2. It can be seen from this formula that close coupling of the valve to the motor is highly desirable. It is usually advantageous to provide cross-line relief within the manifold for overload protection. A cross-line variable orifice can also be added to control viscous damping of the hydraulic actuator.

For loads up to 20 horsepower, where high accuracy is required, the valve-motor system is the recommended approach. A rotary hydraulic piston motor used with an electrohydraulic servo valve can probably meet the accuracy and response requirements of most present and future machines.

In order to provide control, a servo valve is usually designed to have a one-third pressure drop through the valve. The power required to generate this pressure drop represents a heat loss which can become a problem at high flow rates. However, there are several approaches that can be used to solve this problem. One approach involves the use of pressure compensated variable delivery pumps to supply only the flow of oil necessary to maintain a constant pressure. Therefore, if the system requires only internal leakage oil during part of the cycle, this is all that will be pumped.

The ideal system of this type would require a very high response pressure compensator so that the pump could provide demand flow to the servo valve at any instant. In fact, the response of the pump would have to be equal to, or greater than, the frequency response of the servo valve itself. Presently available pressure compensated pumps are not this fast.

Another response problem is the time lag in moving the oil from the pump to the servo valve. An accumulator located near the servo valve can make up the time lag of the pump and the moving oil column. In this way nearly constant pressure can be supplied to the servo valve. Proper sizing of the accumulator is important in order to maintain a minimum pressure variation which otherwise would adversely affect servo valve gain.

Another method of minimizing power loss is the use of a fixed displacement pump in an unloading circuit with an accumulator. When high volume flow is not required, the pump unloads to tank, and the accumulator provides flow. Care must

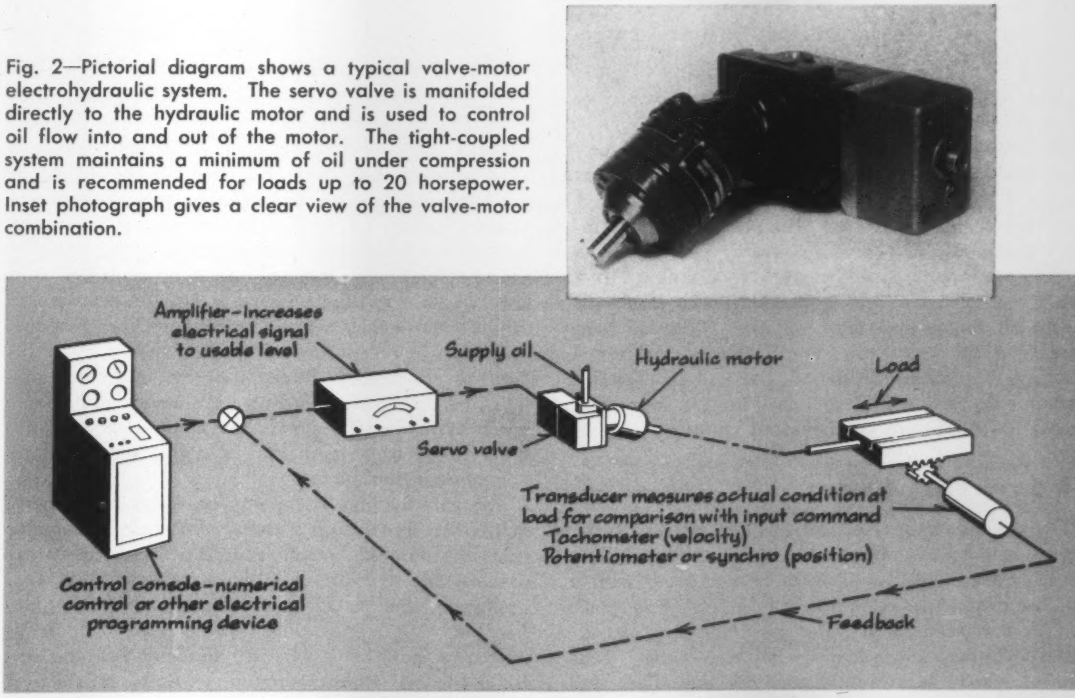

Amplifier–Increases electrical signal to usable level
Supply oil
Hydraulic motor
Load
Servo valve
Transducer measures actual condition at load for comparison with input command
Tachometer (velocity)
Potentiometer or synchro (position)
Control console–numerical control or other electrical programming device
Feedback

Fig. 2—Pictorial diagram shows a typical valve-motor electrohydraulic system. The servo valve is manifolded directly to the hydraulic motor and is used to control oil flow into and out of the motor. The tight-coupled system maintains a minimum of oil under compression and is recommended for loads up to 20 horsepower. Inset photograph gives a clear view of the valve-motor combination.

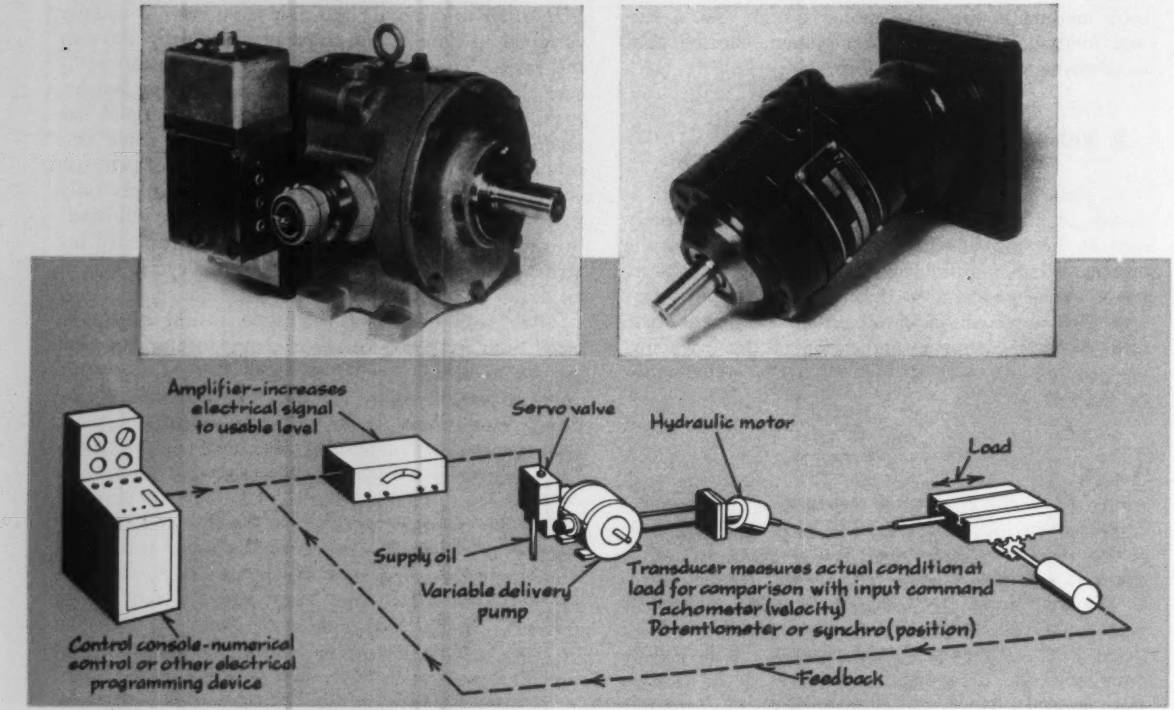

Amplifier-increases electrical signal to usable level
Servo valve
Hydraulic motor
Load
Supply oil
Variable delivery pump
Transducer measures actual condition at load for comparison with input command
Tachometer (velocity)
Potentiometer or synchro (position)
Control console-numerical control or other electrical programming device
Feedback

Fig. 3—For high flow and high horsepower applications, the servo pump electrohydraulic system is recommended. Diagram illustrates a typical system, and the insets show close-up views of the servo valve manifolded to the variable delivery pump and a typical hydraulic motor. The yoke of the pump is positioned by the servo valve to modulate oil flow to the hydraulic motor. Although a relatively large volume of oil is under compression, the pump provides only the amount of flow needed to operate the motor, reducing the heat loss problem to a minimum.

be exercised in designing this circuit to avoid interaction of components and the possibility of continually changing pressure being transmitted to the servo valve.

The valve-motor servo system has both advantages and disadvantages. When the application requires a high degree of accuracy and response and flow requirements are less than 20 to 30 gpm, the valve-motor or valve-actuator type system is usually preferred. It allows tight coupling of hydraulic components, and a single power unit will supply oil for several machine axes. The designed pressure drop across the servo valve constitutes a heat loss; but, when significant, this can be partially overcome by the use of an accumulator unloading system or a pressure compensated pump.

▶ Servo Pump Systems

The second basic electrohydraulic system is the servo pump system, *Fig.* 3. In this circuit, oil flow to the hydraulic motor actuator is modulated with a variable displacement pump. The pump's yoke position or displacement is varied by means of an integral cylinder, controlled by a servo valve. This type of system is normally used for high flow and high horsepower applications.

With this system there is an added time constant for moving the yoke which varies pump flow. This time constant must be added to the over-all response time of the system. Although this is a disadvantage, it is often not the limiting factor in the application. The servo pump system requires a separate pump for each actuator, and it is usually difficult to close-couple a servo pump to the actuator. Thus, a relatively large volume of oil is under compression—a condition which has already been pointed out as sometimes undesirable. The response problem can be minimized by making the hydraulic lines as short as possible, and, for many applications, performance is entirely satisfactory. The servo pump system provides only the amount of flow that is requested from it, making it highly efficient from a heat loss standpoint.

When selecting actuators for either the valve-motor or servo pump systems, there are some basic rules that should be followed. Since it is important to keep the amount of oil under compression at a minimum, the rotary hydraulic motor is the best selection. In applications where the load to be moved is small and a small diameter cylinder can be used, the linear actuator is quite satisfactory.

It is of utmost importance in optimizing the system that every hydraulic and electronic component be carefully selected and analyzed.

The best results in a servo system are obtained with single-source responsibility. This can be the machine builder himself, a qualified consultant, or a responsible component supplier who has broad knowledge of the field and suitable personnel and laboratory facilities. With single-source responsibility, engineering and design work are minimized, and components can be selected for system compatibility and easy maintenance. The net result is better over-all performance, dependability, and savings.

▶ Application Limitations

The application of a very accurate high response control system to a non-rigid machine, or a machine with a low resonant frequency, is time and money wasted. The machine must be capable of handling the actuation applied to it and carrying this actuation to the work itself with sufficient stiffness and compliance so that the directions given it will not be distorted and result in inaccuracies to the work. The over-all machine, like the chain with a weak link, will only be as fast and accurate as the weakest component.

Many machine tool companies are already redesigning their machines, providing extra stiffness and compliance. They are finding new ways of increasing the resonant frequencies of various portions of their machines. Likewise, many hydraulics manufacturers are developing and refining their control and power actuators so that they will not be the limiting factor to the over-all system.

Any system that has been built to date can be powered to its full capacity with today's electrohydraulic servo valves. However, this may not hold true in the future. As machine tool builders continue to develop their techniques in machine design and raise the over-all frequency response of their machines, the power control equipment will have to keep pace. Where the present day closed loop system of 5 to 10 cps resonant frequency is considered good, future systems of 50 and 60 cps will be commonplace.

Present day concepts of multistation automated transfer machines have very nearly run their course. Practically every trick involving on/off hydraulic and/or electric actuation, control, and sequencing has been tried. One often hears the comment that the flexibility offered by electrohydraulics is not required by a transfer machine. This is true in cases where the production run is for a year or more, but recent statistics show that 75 per cent of the metalworking industry is dealing in lots of 50 or less. Today's automatic machines often make 5 to 50 scrap parts before they are set up to produce usable parts. Electronic programming and gaging plus electrohydraulic control eliminate trial and error methods by constantly gaging in process.

In grinding and some milling operations, a closed loop control system can be used directly to compensate for wheel or mill wear. Where tool wear dictates replacement, a servo system can be used for automatically replacing tools. In consumer durables, retooling a servo controlled, building block type transfer machine will involve little more than rearranging stations and reprogramming for new part configuration and dimensions.

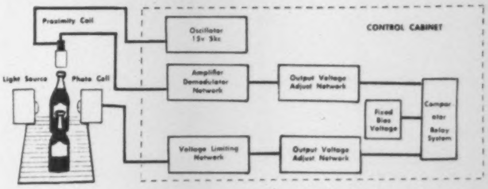
The experience gained thus far in electrohydraulic technology has provided ample proof that this is the next step in the ladder of industrial progress. It means increased production of parts with improved quality at lower cost. It means that a short production run can be made at a cost per piece not far above that of a very long run. It permits a pilot model to be made on a production machine with on-the-spot corrections. It means a greater number of quality products will be available at less cost resulting in a higher standard of living.

detecting uncapped bottles on a filling line

COMBINATION of a proximity limit switch and a photoelectric cell arrangement is used by a food processor in a system to detect the presence or absence of an aluminum cap on a glass bottle in a continuous filling line. The system was developed by Automatic Timing & Controls Inc. to check up to 1000 bottles per minute.

Referring to the diagram, a comparator relay system continuously monitors the output voltages of the proximity switch and the photoelectric cell and compares them to a bias voltage of fixed magnitude. When there is no bottle in the detection position, the voltage outputs of the proximity switch and photoelectric cell balance the bias voltage to prevent relay actuation.

When a capped bottle reaches the detection position, the output voltage of the photoelectric cell drops at the same time that the output voltage of the proximity coil increases. The combination of these voltage outputs is



still sufficient to balance the bias voltage and prevent relay actuation.

As an uncapped bottle passes the detection position, the output voltage of the photoelectric cell again drops, but the output voltage of the proximity coil remains at a low output. Therefore, the bias voltage is no longer balanced and triggers the relay. The defective bottle can be removed from the line either manually by an operator or by automatic devices.

OVERHEAD CONVEYOR UNLOADED PNEUMATICALLY

PICKED orders for electrical components are delivered automatically to the shipping room, and empty parts containers are returned to preselected stations in the stock room, with a continuously circulating handling system in the mail order department of Burstein-Applebee Co., Kansas City, Mo. The system uses an overhead cable conveyor, 437 feet long, built by the Conveyor Div., American Monorail Co., Tipp City, Ohio. Conveying rate is 26 fpm.

In operation, orders are picked manually from stores of up to 20,000 different types of components and placed in parts containers. When an order is completed, its container is loaded onto an empty carrier passing on the conveyor. Carriers are spaced at 5-foot intervals on the conveyor. Each carrier is in the form of a horizontal U-shape with its open end trailing the direction of motion. The containers are of fiberboard, with their tops wider than their bottoms, and have wooden rims around their top edges. They are placed on the moving carriers so that the rims are supported on the carrier arms. Three sizes of containers can be accommodated in the carriers.

Carriers move from the stock room to the shipping room on the floor below. There, they arrive in turn at an unloading station, *Fig.* 1. As a carrier reaches this station, an arm projecting from the carrier actuates a stationary limit switch. This causes a roller section at the unloading station to rise vertically under the force of an air cylinder. Thus, if a container is in the carrier, it will be lifted free of the carrier and held stationary on the rollers. The carrier will continue to move on the conveyor.

When the carrier reaches a point past the unloading station, its arm will actuate a second limit switch that energizes a pusher mechanism at the unloading station. This mechanism includes a horizontal air cylinder that extends to push the container deposited at the station onto a gravity roller conveyor leading to the shipping point. In this manner, all containers in carriers are automatically unloaded at the shipping area. A timer retracts the cylinders to their normal positions between carriers.

Empty containers are replaced in carriers in the shipping area and returned to the stock room on the circulating conveyor. At this time, any of three tabs on each carrier arm may be placed in its raised or lowered position. Each tab corresponds to a station in the stock room where a container can be removed from its carrier.

When a carrier with the proper tab raised approaches the designated station in the stock room, it will actuate limit switches and be unloaded automatically as at the unloading station in the shipping room. If it is desired to route a given container to more than one stock room location, the tab for a subsequent station may be raised at the time the container is loaded in a carrier. The container will then be discharged automatically at a subsequent stock room unloading station.

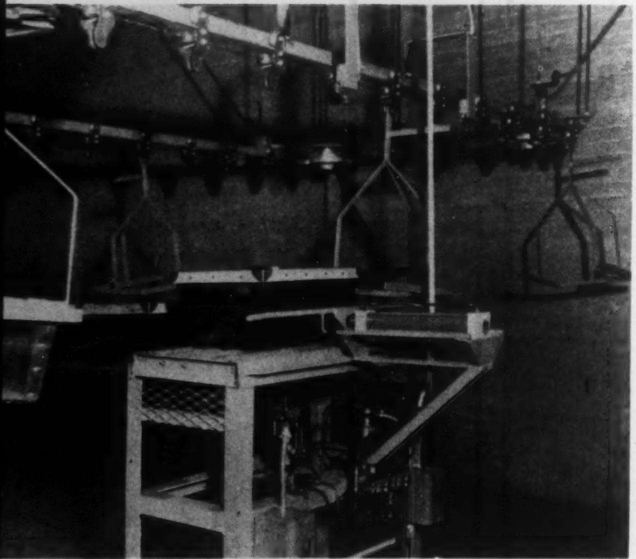
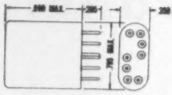
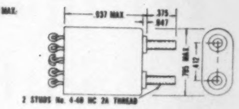


Fig. 1—Containers are automatically removed from carriers on continuously circulating conveyor at unloading station. Limit switches, actuated by moving carriers, operate air cylinders which free containers from carriers and push them onto gravity roller conveyor section leading to shipping point.

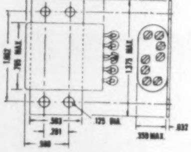
Circle 680 on Page 17→



SC11D
6, 12, 24, 36 Volts



SC11DK
6, 12, 24, 36 Volts



SC11DB
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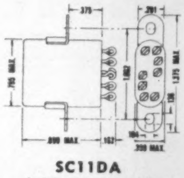
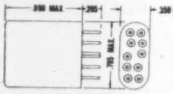


SC11DA
6, 12, 24, 36 Volts

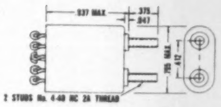
SC

2 TYPES • 4 MOUNTINGS • 4 VOLTAGES

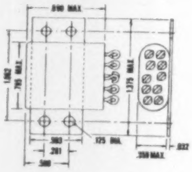
SL



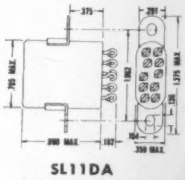
SL11D
6, 12, 24, 36 Volts



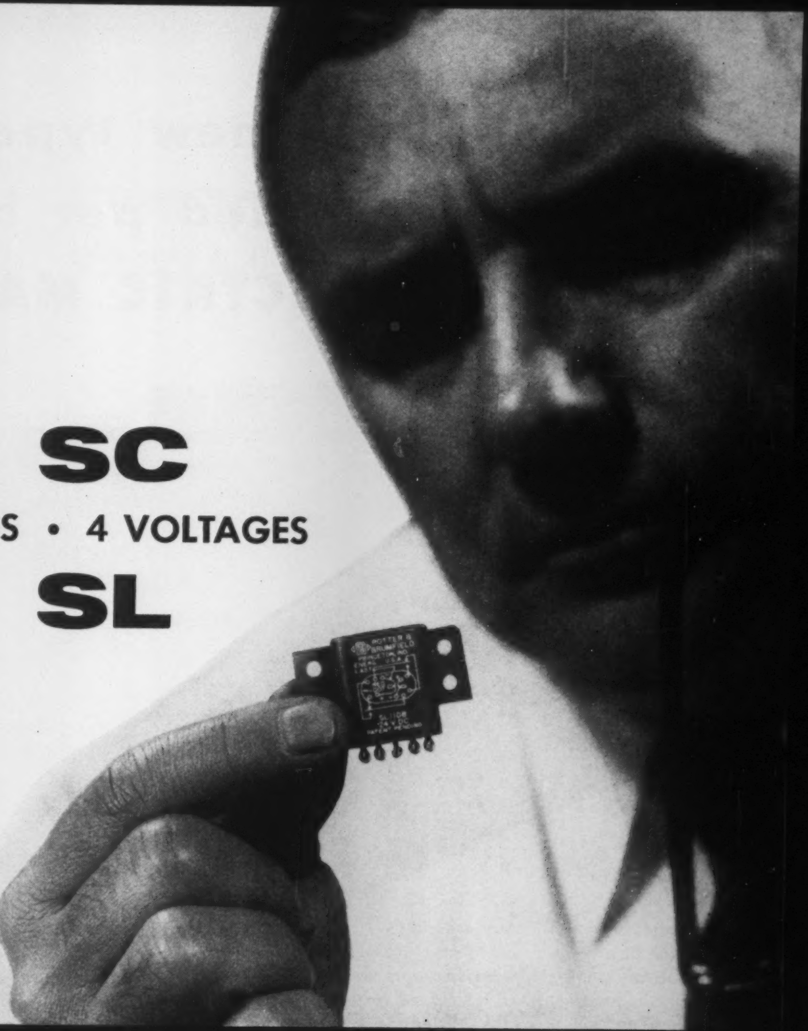
SL11DK
6, 12, 24, 36 Volts



SL11DB
6, 12, 24, 36 Volts



SL11DA
6, 12, 24, 36 Volts



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32 STANDARD P&B CRYSTAL CASE RELAYS

Prototype or small-production-run quantities of P&B's micro-miniature relays are now available from your local electronic parts distributor. Choose from 2 types, 4 mountings, 4 coil voltages—32 models in all.

P&B's dual coil, permanent magnet, crystal case relays remain operative under 100g shock, 30g to 2000 cps vibration. Modern White Room production facilities assure highest possible reliability.

The SC conforms to standard dimensions and circuitry, and can replace ordinary relays of the same size.

The SL, a latching relay, utilizes the dual-coil, permanent magnet principle to provide a highly efficient, tenacious latch, assuring high contact pressure.

Order today from your local electronics parts distributor.

SC and SL SPECIFICATIONS:

Shock: 100g for 11 millisec.

Vibration: 30g from 55 to 2000 cps
.195" max. excursions from 10 to 55 cps

Ambient Temperature Range:
−65°C. to +125°C.

Contact Arrangement: dpdt

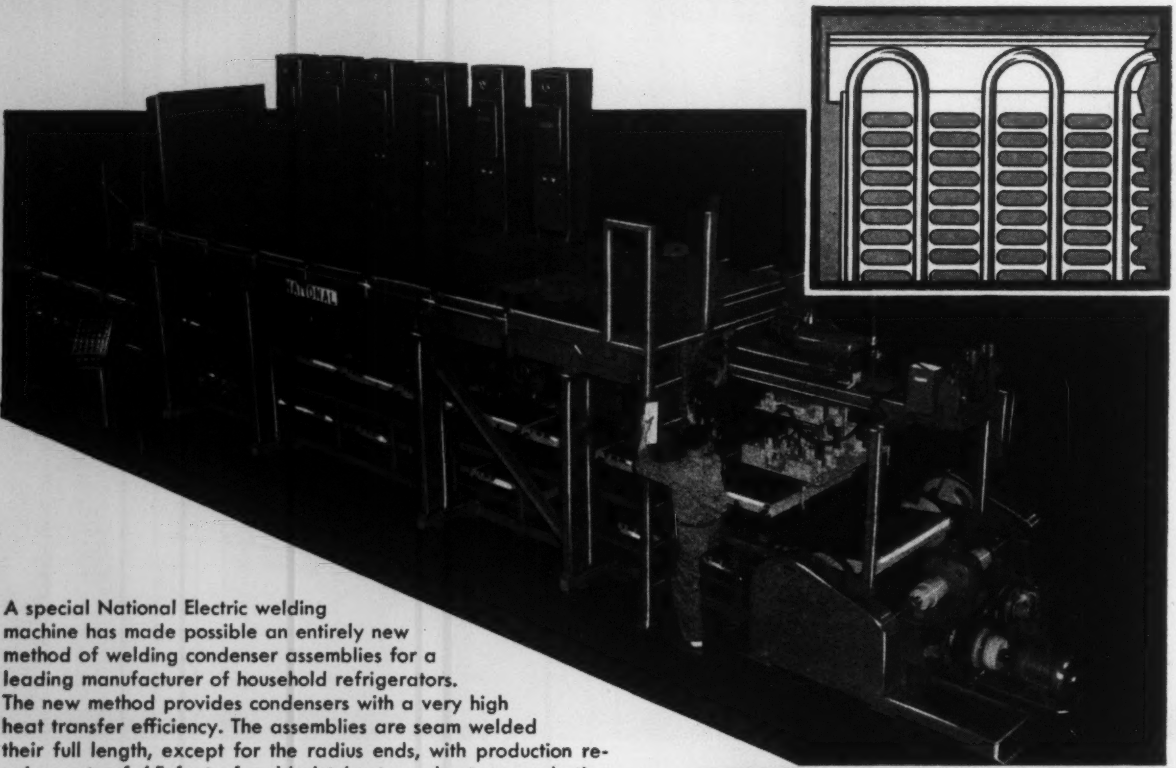
Contact Load: 2 amps at 30 vdc
1 amp at 115 vac, 60 cycle

Sensitivity:
SL—230 milliwatts at 25°C. with 630 ohm coil
SC—260 milliwatts at 25°C. with 550 ohm coil

POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA
IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

THREE HUNDRED new type refrigeration condensers welded per hour with NATIONAL ELECTRIC MACHINE



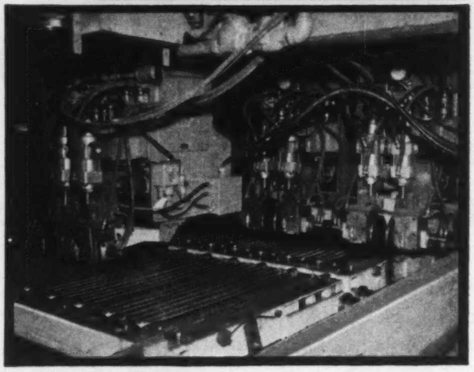
A special National Electric welding machine has made possible an entirely new method of welding condenser assemblies for a leading manufacturer of household refrigerators. The new method provides condensers with a very high heat transfer efficiency. The assemblies are seam welded their full length, except for the radius ends, with production requirements of 65 feet of welded tube to a sheet, a production rate of 300 condensers per hour and a total of 9,700 feet of seam welding to be done per hour. The weld itself is the joining of a tube ¼" O.D. by .028 wall thickness to a formed sheet .010" to .014" thick.

To meet these requirements, National Electric Welding Machines Company designed and built a special Multi-Station Resistance Welding Machine with 34 seam welding wheels and 17 welding transformers, each transformer rated at 70 KVA.

In operation, formed tube is loaded by an operator on to one of 36 carriages traveling at a constant welding speed. (The sheet is automatically received from its forming machine.) Sheet and tube then move through the 16 welding stations. (A 17th is utilized as a standby.) The complete seam welded assembly is removed from the carriage by electro magnets and dropped to an unloading conveyor.

If you have a production welding problem, National Electric can develop an automatic welding machine for you that will assure higher production and lower cost per weld. Write today for complete information.

56



NATIONAL
Electric
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1870 N. TRUMBULL STREET
BAY CITY, MICHIGAN

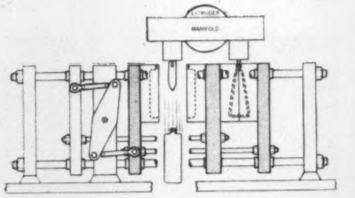
25 YEARS EXPERIENCE DESIGNING AND BUILDING: SPECIAL & STANDARD • AIR • HYDRAULIC • MOTOR DRIVEN • SPOT • PROJECTION • SEAM • BUTT • FLASH • RESISTANCE WELDERS • PRODUCTION FIXTURES FOR ALL TYPES OF AUTOMATIC ARC WELDING.

Circle 681 on Page 17

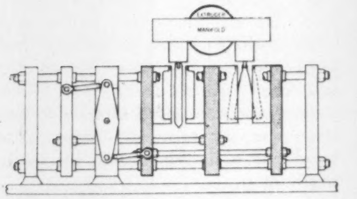
AUTOMATION

new equipment

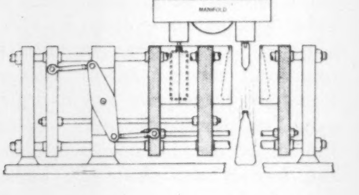
Machines and plant equipment for more automatic operations.
For detailed information and literature, use card on page 17.



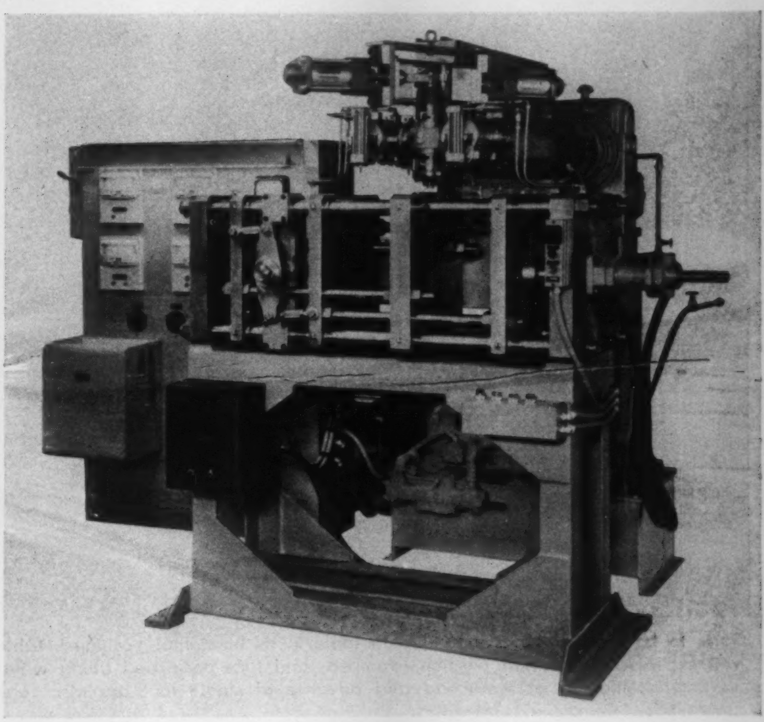
Machine feeds extruded plastic tubes between open cavities of two left sets of molds as previously blown products are ejected. A valve on the extruder head synchronizes material feed with the molding cycle. The right side pair of molds is closed for the blowing and cooling operation.



A timer is adjusted so that, as the extruded material on the left side reaches the correct length, the mold halves on the left side begin to close. The molds on the right side automatically open and the molded products are released from the molds.



When the molds on the left side are closed, the molds on the right side are open and the finished products ejected. When the left side has cooled, the extruded material on the right side has reached the correct length and the cycle automatically repeats.



Automatic plastics blow-molding machine accepts four molds—two on each side of center platen. Feeding of extruded material on one side during molding and cooling on other side permits molding up to 140 pounds of material per hour.

Automatically Cycled Blow Molders

HOLLOW plastic items such as toys, bottles, and containers up to 6 inches in diameter and 32 inches in length are blow-molded by Model 150-7, designed by **Auto-Blow Corp., Subsidiary, National Tool Co.**, 401 Bishop Ave., Bridgeport 10, Conn. The machine allows molding of up to 140 lb of material per hour from a continuously running extruder. The molding function takes place at two positions with two molds located at each position.

The machine has three mold platens which move back and forth in a horizontal plane. Two mold cavities are placed on each face of the center platen and mating halves are placed on the inner faces of the end platens. With four extruder heads (one above each mold set) material extrusion to the open mold sets on one side of the center platen takes place simultaneously with blow-molding and cooling in the closed mold sets on the other side.

In operation, as the molds on the right side close to mold and cool, a mechanical linkage automatically opens the molds on the left side for material extrusion. When the material reaches the correct length, the molds on the left side close to mold and cool, automatically opening the right side molds. The two finished products on the right side are then ejected and material extrusion begins. This shuttle action cycle repeats automatically from left to right at speeds up to 2500 cycles per hour.

Feature of the unit is a valve on the extruder which automatically synchronizes the material feed with the molding cycle to the four extruding heads located directly above the parting lines of the molds. Each extruding die has adjustments to regulate material wall thickness and an individual heat control to equalize the speed of material flow.

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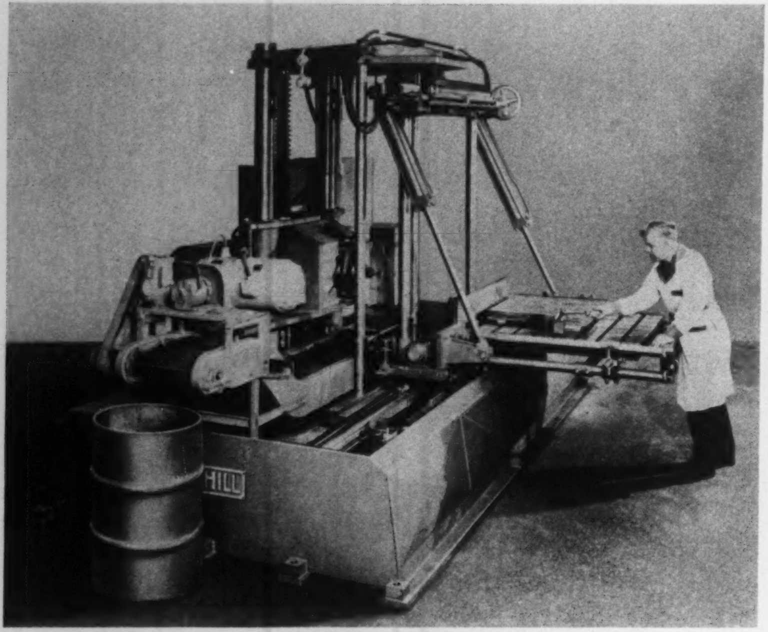

Parts to be machined are loaded onto table in its horizontal position. Table will be raised to vertical position, clamped, and tape-positioned along ways. Vertical positioning of workhead and advance of single tool are also tape controlled.

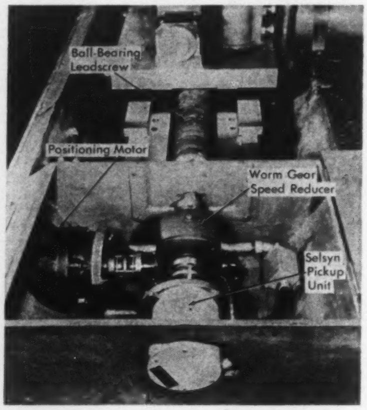

Table positioning system employs a reversible dc positioning motor which turns leadscrew through reducer. Main force for moving table comes from auxiliary hydraulic cylinder. Selsyn pickup unit, connected directly to leadscrew, senses table position. Workhead has a similar system for vertical positioning.

Tape Programmed Machine Tool

Item 402

Numerically-controlled, single-spindle machine is capable of performing drilling, milling, or jig-boring operations. Secondary operations such as reaming, gun-reaming, chamfering, and counterboring can be performed with the same tape following a programmed drilling sequence. Unit combines a General Electric numerically controlled positioning system with a hydraulic control system. Punched tape made from typewritten instructions is used to carry out a programmed spindle location and operation sequence.

Three independent hydraulic systems are provided on the machine. One is used for the table drive, the second for the vertical head drive and the third for the drill feed and table tilt functions. The table, which has a 25-ton capacity, travels on hardened and ground flat ways. A ball bearing leadscrew attached to the table is connected to a numerically-controlled positioning motor through a worm gear speed reducer. The leadscrew is also directly connected to a selsyn pickup director unit.

In operation, the table is lowered to load the machine with a part or tube sheet assembly. With the work clamped on the slotted table, pushbutton operation causes hydraulic cylinders to raise the table into vertical position. The table is next automatically locked by a hydraulic cylinder-controlled shot pin mechanism. Then the work is programmed automatically through an entire drilling sequence. To index the table and head to a new position, positioning motors for each unit start to turn. This releases the leadscrews and hydraulic cylinders move the units. When the units are in proper location, the motors are shut off, locking the leadscrews and preventing further unit motions. Selsyn pickups check each unit position and automatically correct any error. Then the drilling sequence is initiated. If a different part has to be programmed, or a different pattern is desired, no machine modification is required. Another punched tape is prepared and put on the tape reader. **Walter P. Hill Inc.**, 22183 Telegraph Rd., Detroit 19, Mich.

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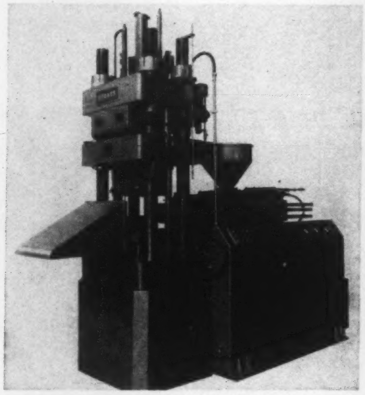


Injection Molding Unit

Item 403

Six-ounce injection molding machine is adaptable for producing relatively large parts such as automobile taillights, cases for portable radios, and dials for TV sets as well as small parts. Model 704 combines vertical clamping with horizontal combing. The degated parts are ejected horizontally and can be deposited on a conveyor or dropped down a chute into bins. Barriers can be incorporated in the horizontal comb to direct different type of pieces molded at one time into separate bins. The pieces can be kept oriented with respect to each other exactly as they were molded. This feature permits automatic packaging at the machine, or it could facilitate automatic assembly operations later on.

Positive shutoff at the injection nozzle permits the molding of nylon without drooling and without changing the nozzle for this type material. The nozzle shutoff feature also permits prepacking the injection cylinder at high pressure during the cooling cycle to give faster filling and compression. Cycle time of this unit is 8 seconds from mold opening to the beginning of fill. **F. J. Stokes Corp.**, 5500 Tabor Rd., Philadelphia 20, Pa.

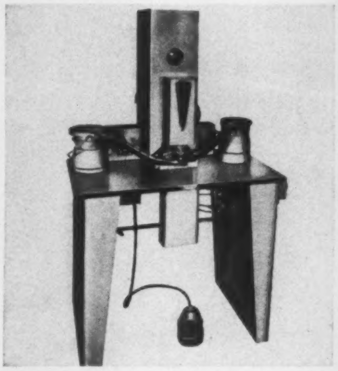
Circle 403 on Page 17

Readout Printer

Item 404

Data printer can be used for recording automatic check-out data, logging instrumentation data, recording quality control reports, automatically recording inspection records, and printing gummed labels and inspection tags. Model 1941 has a paper transport mechanism which precisely positions preprinted forms. It features an automatic form ejector. Printing data sources include digital voltmeters, shaft position transducers of both the decimal and coded types, electronic counters, step switch banks, and relay banks. An original and three carbons can be printed at the rate of $2\frac{1}{2}$ lines per second. **Clary Corp.**, 408 Junipero St., San Gabriel, Calif.

Circle 404 on Page 17



Automatic Inserter

Item 405

Automatic device can feed and insert simultaneously a variety of pairs of small parts such as terminals, connectors, pins, studs, or two-piece bushings and feed-through type terminals of the kind used in electronic circuit boards. In operation, parts are fed from two hoppers through chutes which put them in proper position. Then they are pressed lightly into place by a cam-operated ram. The ram can be adjusted for pressing force, speed, and stroke. A lower unit incorporates a retractable pin which facilitates accurate positioning of parts if required. The cycle is initiated by means of a two-position foot switch. Insertion rates are up to 3000 pieces per hour. **Hill Machine Co.**, 1301 Eddy Ave., Rockford, Ill.

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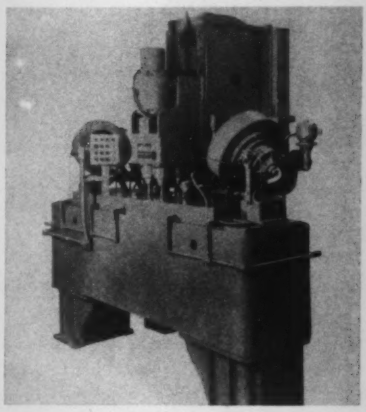


Lead Screw Tapper

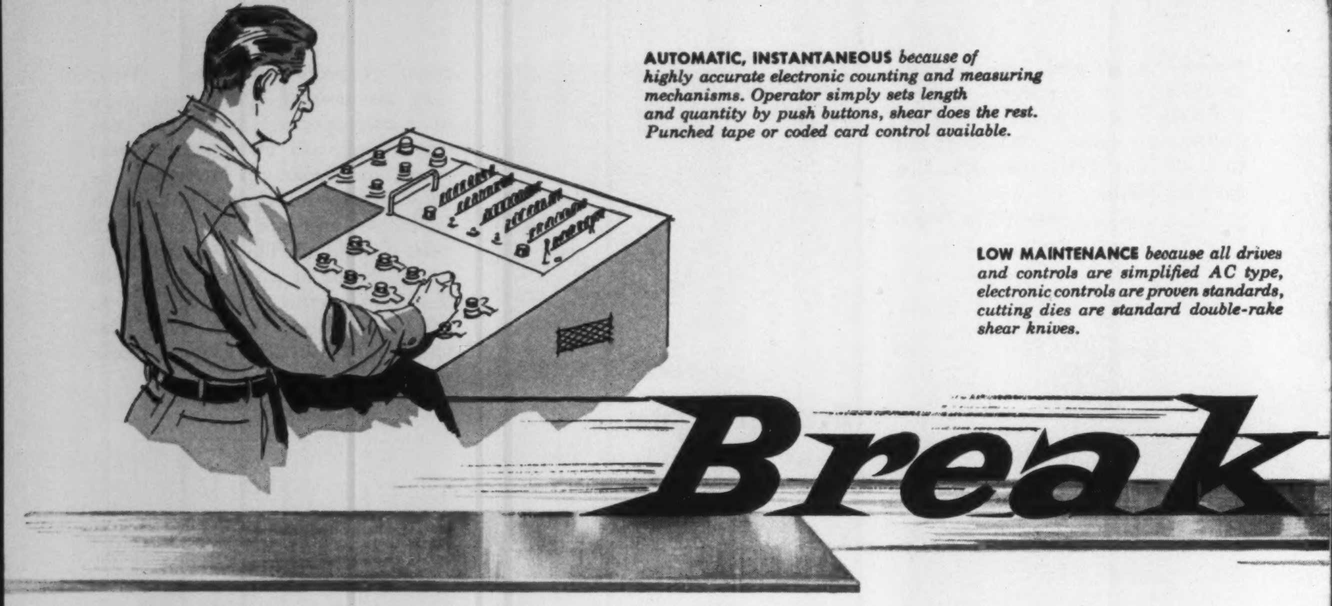
Item 406

Four-spindle machine is designed to process $\frac{1}{2}$-inch electrical conduit lock nuts. It is capable of selecting, positioning, loading, tapping, and ejecting 1215 pieces per hour when operated at 80 per cent efficiency. Model 409-S consists of a vertically mounted, multispindle tapping unit, two motorized hoppers and feed mechanisms, and four fixtures, all mounted on a common cast iron base with a platen face machined on top. All components in the unit are automatically lubricated with an oil mist lubricating system.

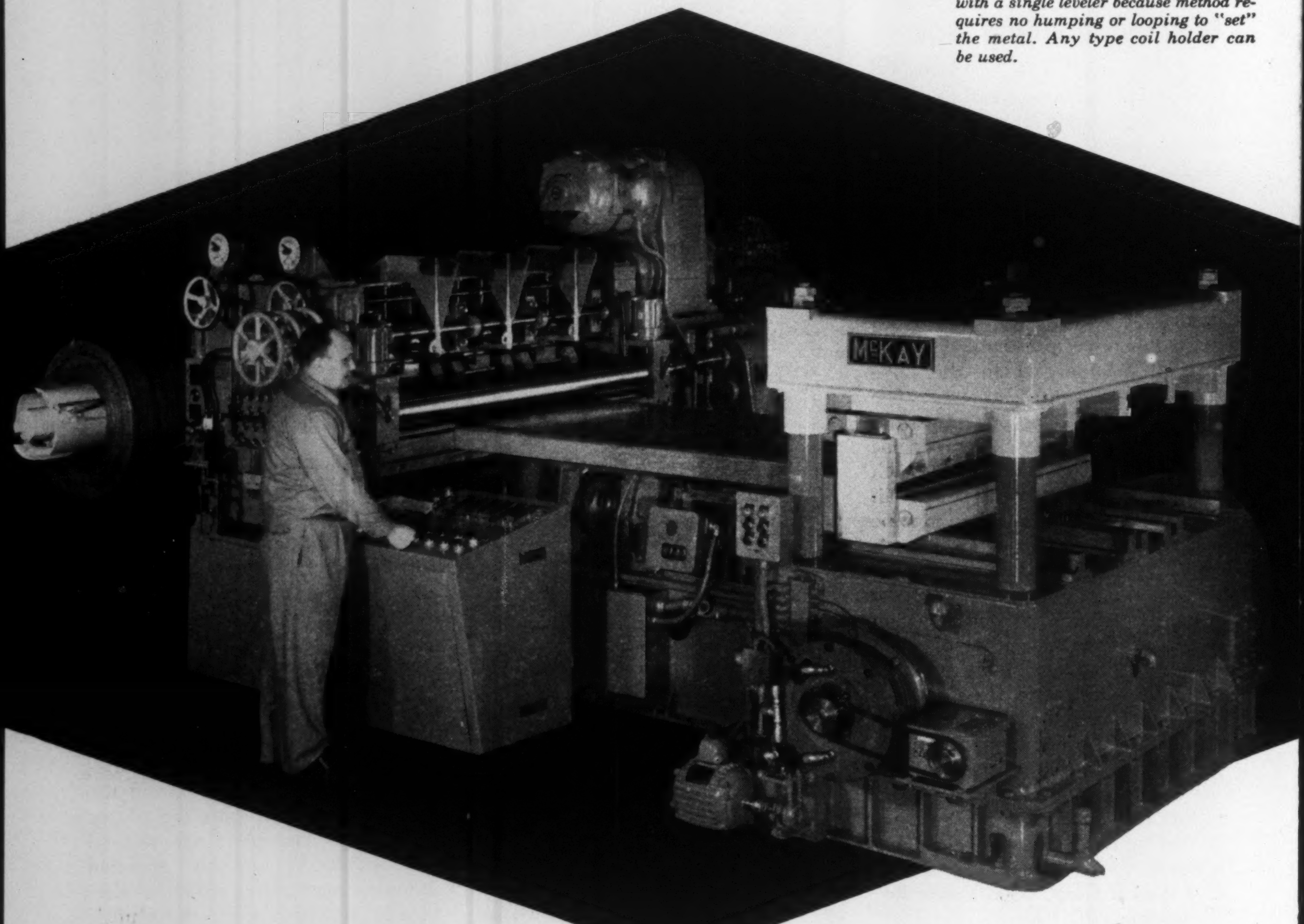
In operation, the parts are transferred to the work holding fixtures by an air operated shuttle mechanism. The parts are oriented so they arrive with their concave sides down. As the parts enter the fixtures, cog-like guide rails orient the lock nuts on their lugs for proper positioning. The parts are secured in position by an air operated clamping mechanism which is electrically actuated when the shuttle has correctly positioned the parts. After the unit is cycled, the part is

AUTOMATIC, INSTANTANEOUS *because of highly accurate electronic counting and measuring mechanisms. Operator simply sets length and quantity by push buttons, shear does the rest. Punched tape or coded card control available.*

LOW MAINTENANCE *because all drives and controls are simplified AC type, electronic controls are proven standards, cutting dies are standard double-rake shear knives.*



COMMERCIALLY FLAT SHEET *is possible with a single leveler because method requires no humping or looping to "set" the metal. Any type coil holder can be used.*



COMPACT . . . *never before has such a high production unit required so little area. Space saving, it's ideal for warehouse operations.*

through...

in AUTOMATIC SHEARING

Revolutionary McKaymatic* high production Die Shear line instantly responds to length and Quantity Command

Now—a high production cut-to-length line that meets *all* the requirements of modern day coil shearing. It's the revolutionary new McKaymatic* Die Shear Line and it's fast, extremely accurate, instantly adjusted, compact and relatively low in cost!

The McKaymatic* is applicable for use wherever sheet metal is used. Ferrous and non-ferrous mills, fabricators or warehouses should see this amazing new line before they decide on the purchase of new coil shearing equipment.

UNMATCHED FLEXIBILITY offered by a simplified electronic control makes the changing of length of cut instantaneous. When length and quantity commands are changed (manually or automatically) the line reacts instantaneously without slowing down or stopping. EXACTING ACCURACY, also a product of electronics, is equal to or better than any other available equipment. HIGH PRODUCTION, regardless of the number of length changes is possible because there is no downtime for length changing, etc. LOW MAINTENANCE is possible because the line is designed around simple AC drives and controls, and proven electronic components.

There's nothing like it—for large orders or small—in any width or thickness. Here for the first time is practical push button shearing, and it's easily adapted for standard coded card or punched tape systems. For details write today. *The McKay Machine Company, Youngstown 1, Ohio.*

*TM

McKAY
McK
MACHINE

Circle 682 on Page 17

automatically unclamped and ejected to a tote basket as the unit retracts. Cycle time is approximately 9.5 seconds, based on operating the taps at 35 sfpm. **Morris Machine Tool Co.,** 2011 Eastern Ave., Cincinnati 2, Ohio.

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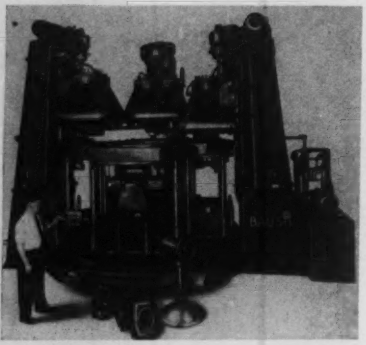

Multistation Machine

Item 407

Unit features mechanical leadscrew feeds for drilling, tapping, and reaming operations. Model M-20 is equipped with a 124-inch diameter automatic rotary table that has four indexing stations. The machine illustrated has a total of 96 spindles on adjustable arms. The sequence of operations is: Load and unload; multiple drilling operations; multiple drilling, chamfering, and reaming operations; and multiple tapping operations.

Three vertical multiple spindle units have 27 by 40-inch rectangular heads with automatic cycling for high production; semiautomatic cycling for low production; and a jog cycle for setup. Each head is bored for 32 spindles with 32 upper spindle drivers 1½-inch in diameter, arranged for 2 speeds and a neutral position. Feed can be varied from 0.005 to 0.090 inch per revolution and spindle speeds can be varied from 130 to 1050 rpm. Spindles can be disengaged for various cycles by position selector knobs on the tops of the heads. When a head goes from rapid traverse to feed stroke, an electric brake holds the leadscrew and shuts off the traverse motor, lessening wear and tear. **Baush Machine Tool Co.,** Springfield, Mass.

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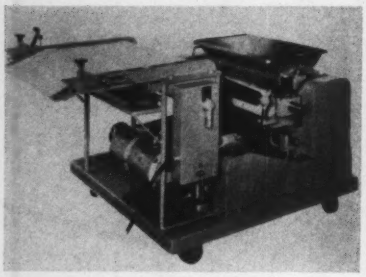

Biscuit Molder

Item 408

Capable of producing all types of biscuits of the shortbread variety, portable unit is designed to service ovens of any length. Open areas under the apron and rollers provide accessibility for easy cleaning. Features of the machine include: Removable stainless steel hopper, adjustable transfer apron, apron scraper with catch pan, and an adjustable pressure roll. Knives of the unit are adjusted by two handwheels. Machine is available with either a 32 or 38-inch width. **Food Machinery Div., Baker Perkins Inc.,** 1000 Hess, Saginaw, Mich.

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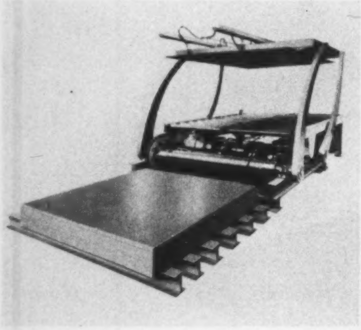

Plate & Sheet Feeder

Item 409

Vacuum-type equipment can automatically pick up plates or sheets one-at-a-time from a stack and transport them in a horizontal plane to a position about 1 inch above a powered roll-feed table. When the vacuum is released, the plate or sheet drops onto the feed table. It is then aligned and advanced by the roll feed. A typical application would be to feed a press at a rate of one 8 by 12 ft. plate per minute.

After a plate has been released, a set of pivot arms returns the vacuum lifting mechanism to the stack. A probe adjusts to changing stack heights. The next plate is then picked up and positioned over the table. This plate may be dropped automatically on the table or held until the operator presses a *Vacuum Release* pushbutton. Unit includes a platform of beams provided with side guides that align the stack of plates approximately with the machine being serviced. The open-type construction of the platform permits easy removal of grab hooks and bands around the stacks. Setup can also be used as a stacker. **Herr Equipment Corp.,** 1201 Vine St., Warren, Ohio.

Circle 409 on Page 17

Tape Message Relay

Item 410

Automatic, self-contained, punched tape message relay can receive wire signals at speeds ranging from 60 to 200 words per minute. It then converts them into perforations in paper tape and transmits them to local or remote receiving stations. Applications include use as an input-output speed converter, intermediate message storage, business machine-communications link, automatic data accumulator, and control device for automated factory equipment. Model 28-RT has three message relaying devices: A receiving unit for accepting incoming wire signals, punching and printing the signal data on paper tape; a sending unit for reading and translating the taped data into electrical impulses for transmission; and a tape handling unit with tape supply reel, intermediate tape storage bin, and tape winder reel. The receiving and sending units can operate at the same or different speeds. **Teletype Corp.**, Dept. SP-4, 4100 Fullerton, Chicago 39, Ill.

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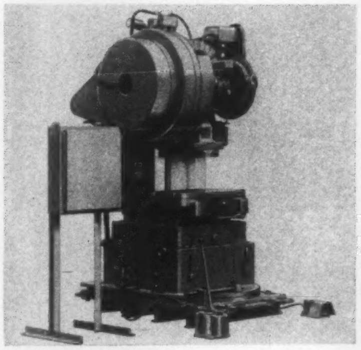

Cutoff Press

Item 411

Designed for use with rolling mills, flying cutoff press is synchronized with the speed of the mill by means of an air clutch control panel to cut lengths of metal channels, bars, angles, and moldings. Construction of the optional press base allows rotating the press 360 degrees; hydraulic power allows tilting it to form shapes. Presses use web-type flywheels, and have long vee-type ways and gibs. Models are available in capacities up to 100 tons. **Federal Press Co.**, Elkhart, Ind.

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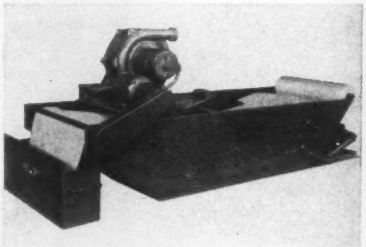


Vacuum Filter

Item 412

Designed for the continuous filtration of water-soluble coolants for machine tools, automatic self-cleaning unit uses vacuum to greatly augment the effect of gravity. Filter consists of a combination vacuum chamber and clean supply tank which is located under a wire mesh belt. The filter medium, of special paper, is supported by the endless wire mesh belt. The vacuum holds the paper snugly against the belt. In use, dirty coolant flows by gravity onto the filter paper and is distributed over the width of the paper's surface. Solid particles removed from the coolant are deposited on the paper and built up in the form of a cake. When the cake reaches a point where suction can no longer be maintained to draw the coolant through the paper, a vacuum switch actuates the drive mechanism, moving the supporting belt and paper forward to provide a new filter area. Simultaneously, sludge and paper are discharged into a tote box. The cool, clean coolant is delivered back to the work by a supply pump. **U. S. Hoffman Machinery Corp.**, Dept. LR, Thompson Road Plant #1, Syracuse, N. Y.

Circle 412 on Page 17

FAST, AUTOMATIC CUT-OFF of TUBING and BAR STOCK

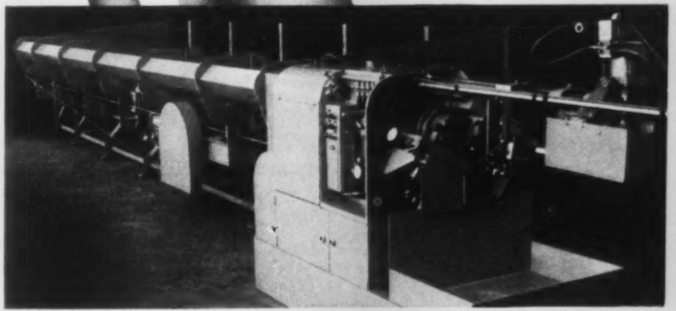
with automatic loading, combined with forming, grooving, flanging or chamfering in a single operation!

the Modern Way

The illustration shows the Modern Automatic Cutting-Off Machine, equipped with automatic feeder which holds up to 100 bars of 3" stock. Stock can be random lengths, which are fed, measured, trimmed and cut.

This machine, known for years for its fast, efficient cutting-off, can now be equipped with special tooling for grooving, flanging, forming and chamfering while cutting-off at a high rate of speed.

The cost savings made possible by combining these operations merit your serious consideration. If you have to cut tubing or round bar stock — particularly with grooves or forming required near the ends — send your prints for our recommendations.



WRITE for CATALOG

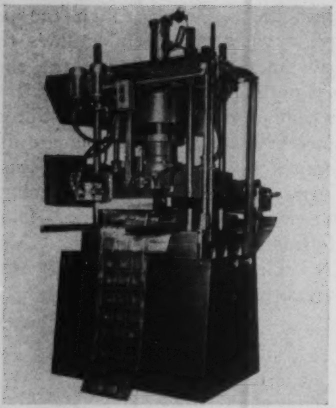
New catalog describes all models—gives production figures. Mailed on request.

110

MODERN MACHINE TOOL CO.

2005 Losey, Jackson, Michigan

Circle 683 on Page 17



Automatic Die Cutter

Item 413

Adaptable to receive product from continuous forming machines, unit is capable of cutting plastic and plastic-type material continuously from a roll of material, or from continuous lengths of vacuum or pressure formed web. Inexpensive steel rule dies may be used. Cutter can feed, die cut and eject material at up to twenty strokes per minute. The index of the feed is precision adjustable from six to twelve inches. Feature of the cutter is an air hydraulic heat device which permits a clean cut edge in plastics such as styrenes. Required air pressure is 100 psi. **Tronomatic Machine Mfg. Corp.**, 1881 Park Ave., New York 35, N. Y.

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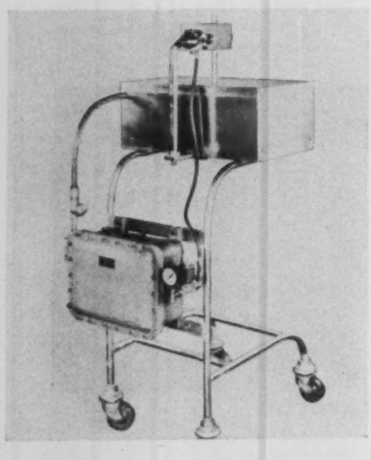

Paint Spray Unit

Item 414

System is capable of automatically spraying test panels in a predetermined cycle. Designed for use in a laboratory type spray booth, the device reciprocates a panel back and forth in front of an automatically controlled spray gun. One of its uses is for color-matching of paints such as the new acrylics. The gun sprays at predetermined intervals, stopping at the end of the cycle. Unit is explosionproof, will accurately repeat its preset cycle. **Spraymation Inc.**, 25 Amity St., Little Falls, N. J.

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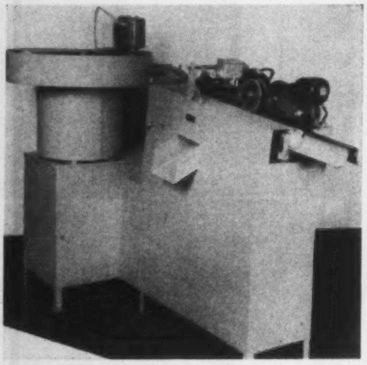

Parts Feeder

Item 415

Designed to feed cylindrical bearing races of various sizes and shapes to a centerless grinder, unit can also be used to feed parts to operations such as printing, stamping, and forming. In operation, the part receives a first orientation in a centrifugal-type feeder; it is then fed through adjustable tracks into a final orienting unit. From the discharge section of this unit, the part is fed to its point of use. The feeder will orient and feed parts as a continuous tube. When feeding a grinder, a linear rate of feed of 100 ipm is maintained. An electronic control prevents the machine from overfeeding. **U. S. Engineering Co.**, 40-28 22nd St., Long Island City, N. Y.

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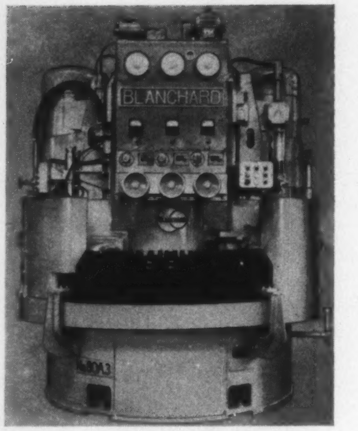

Surface Grinder

Item 416

Automatic surface grinder has a 48-inch ID by 80-inch OD worktable and 3 grinding wheel spindles. Each wheel is maintained at correct height by a finger-type feed control caliper; all parts are held in fixtures during the grinding cycle. Illustration shows the machine rough grinding both sides of both ends of automotive connecting rods. Specifications of Model 80-A3 are: Wheels—18-inch cylinder or 22-inch segment; motors—25, 30, or 40 hp each spindle, 3 hp for the table. **Blanchard Machine Co.**, 64 State St., Cambridge, Mass.

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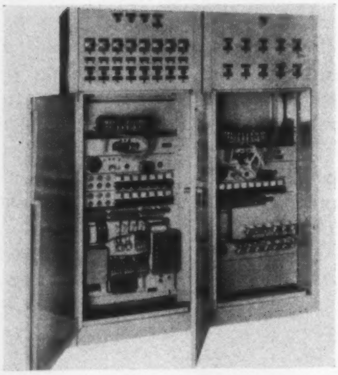

Telemetering Transceiver

Item 417

Instrument is capable of multiplexing up to 28 signals over one pair of low-rate telegraph wires. The pulse signals can operate valves, gates, motors, alarms, lights, and indicating and recording devices. Identical units transmit and receive both metering and control signals bidirectionally and in a loop. A sweeping arm uses a permanent magnet which does not touch the switches to actuate them. This action is said to minimize contact friction and arcing at the switches, and reduce arm motor load. Unit monitors its own signals and synchronizes every six seconds. Time delays prevent a signal from being relayed until it has been confirmed a number of times. **Automatic Control Co.**, 999 University Ave., St. Paul 4, Minn.

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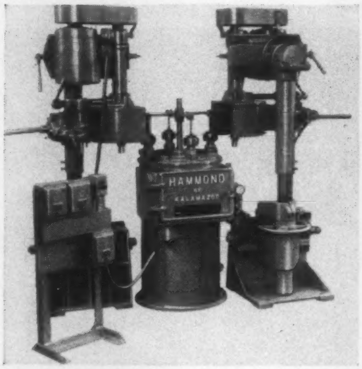

Rotary Indexing Turret

Item 418

Basic indexing unit is adaptable for use with one, two, or three polishing, buffing, or deburring heads. Model J21-4 requires four work-holding fixtures, has an adjustable operating range of 250 to 600 indexes per hour. A positive table lock is available to be used for polishing operations or whenever all table movement must be stopped during the working cycle of the machine. **Hammond Machinery Builders Inc.**, 1650 Douglas Ave., Kalamazoo, Mich.

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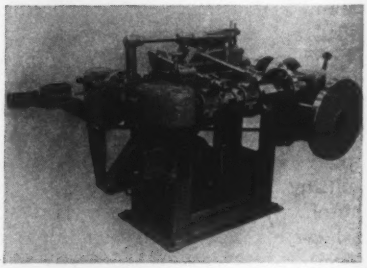


Forming Machine

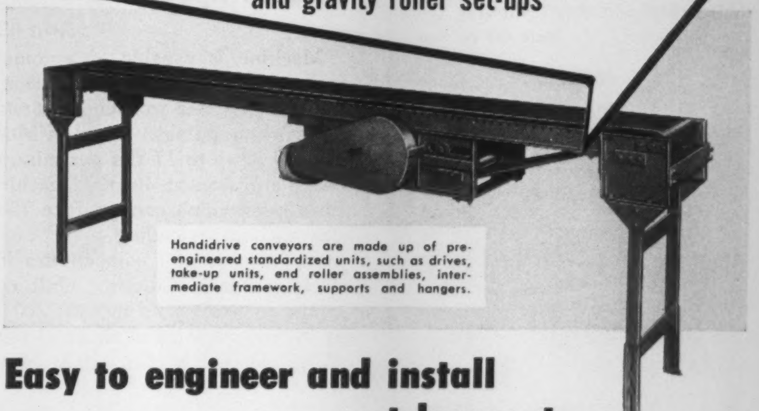
Item 419

Designed to stamp and form ribbon metal in one operation, combination press and four-slide forming machine is also capable of forming wire with a maximum feed length of 8 inches. It can handle wire up

NOW ... "custom plan" your conveyor system with *Standard*

HANDIDRIVE

and Standard units for complete belt, "live" roller and gravity roller set-ups



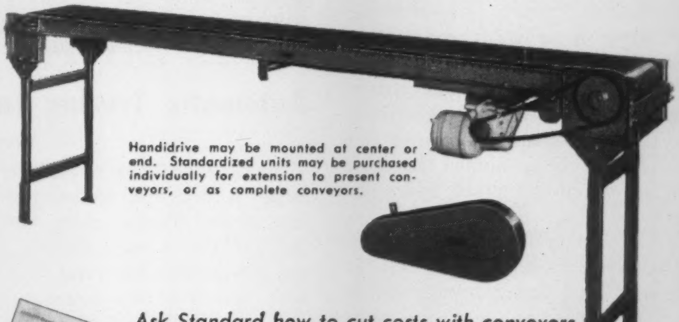
Handidrive conveyors are made up of pre-engineered standardized units, such as drives, take-up units, end roller assemblies, intermediate framework, supports and hangers.

Easy to engineer and install ... at low cost

You can assemble and build a system "custom-planned" to suit your individual needs with Handidrives and other Standard units available out of stock. This service enables you to adapt and change the system from time to time to meet varying requirements as they arise, at exceptionally low cost.

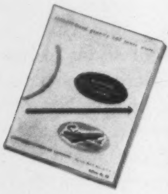
Handidrive conveyors may be individually leveled or inclined. Independent units may be purchased separately to construct power conveyors as desired.

Let Standard show *you* how to build or convert your own conveyor systems with Handidrives. Write: STANDARD CONVEYOR COMPANY. General Offices: North St. Paul 9, Minn.



Handidrive may be mounted at center or end. Standardized units may be purchased individually for extension to present conveyors, or as complete conveyors.

Ask Standard how to cut costs with conveyors



Send for Handidrive Bulletin No. 64. Write Dept. EE-7.

Standard

GRAVITY & POWER CONVEYORS

Sales and Service in Principal Cities

OVER 50 years of conveyor experience

Circle 684 on Page 17

to 3/32-inch in diameter and ribbon metal up to 1¼-inch wide. Feature of the unit is the position of the variable speed motor drive—directly in back of the machine to reduce machine length. Other features include: Double gibs, a twin disc clutch, and redesigned gear guards. The built-in press section has a ¾-inch stroke and a maximum pressure capacity of 8 tons. A 2 hp motor drive permits a speed range from 57 to 200 strokes per minute. **A. H. Nilson Machine Co.,** 600 Bridgeport Ave., Shelton, Conn.

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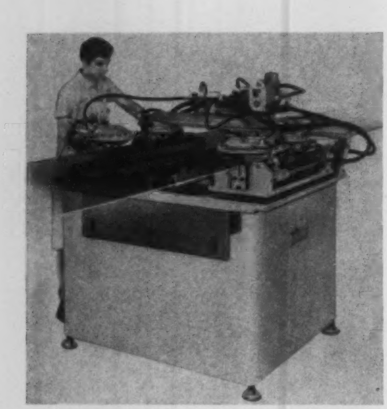

Pneumatic Hitch Feed

Item 420

Designed to automatically feed material into presses or shears, unit is available in sizes to handle materials up to 36 inches wide, 48 inches wide, and 60 inches wide. In operation, the stock is gripped along both edges of its width and carried forward by two gripper heads, each sliding on guide bars. The stroke length is infinitely adjustable from zero to the maximum stroke of the unit. Stroke is cushioned at each end by a self-contained hydraulic check.

Unit can feed from any side of a press—front, back, right, or left. It can be moved easily from press to press or shear to shear; the only connection necessary is the mounting of a limit switch so that it can be tripped on the upstroke of the press or shear. This energizes a solenoid operated valve which in turn cycles the feed. **Special Engineering Service Inc.,** 8161 Livernois Ave., Detroit 4, Mich.

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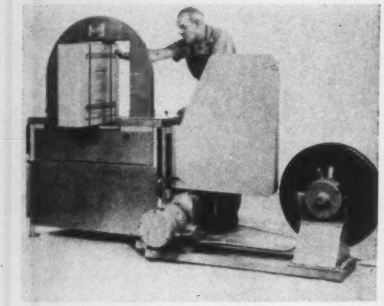

Steel Strapper

Item 421

Machine is capable of automatically binding corrugated cartons, fiber cartons, and wooden cases with flat steel strappings. Speed of Model 2700 is up to 17 ties per minute. Seals are formed in the machine from coils which can produce 7500 ties without reloading. An automatic tension unit compensates for package size variations. Unit operates on two ½ hp motors, 220 v, 60 cycle, 3 phase, and air at 90 psig. **A. J. Gerrard & Co.,** 1950 Hawthorne Ave., Melrose Park, Ill.

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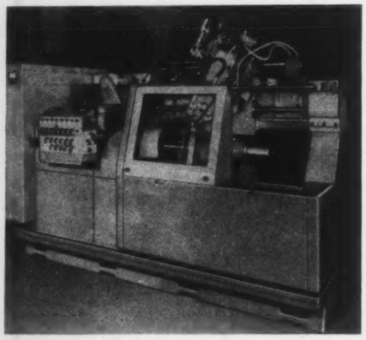

Automatic Tracing Lathe

Item 422

Single spindle, automatic tracing lathe is designed to accommodate one of two tracing units. One unit can perform a single tracing cut in an automatic cycle and the other unit performs two automatic tracing cuts with an indexing tool holder. Two different styles of headstocks are available. One permits shifts between two speeds, the other permits shifts between four speeds. Other features of the machine include: Flexible controls which can be programmed from the operator's station; stylus and templates placed away from chips or coolants; and a large area for automatic loading and chip disposal. Lathe has a 23-inch diameter swing over the rails, 13½-inch diameter swing over the tracer slide. Maximum length of work between the centers can be 24, 48, or 72 inches. **Jones & Lamson Machine Co.,** Springfield 16, Vt.

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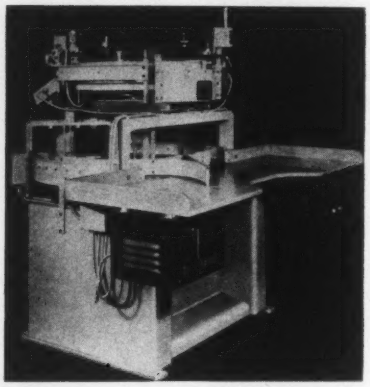

Small Parts Packager

Item 423

Machine counts and places discrete parts such as machine nuts in boxes. In operation, Model 636 receives cardboard boxes from an operator, conveys them to filling position under a spout, counts out a predetermined quantity of machine nuts as they drop into the box, and returns the filled box to the operator. Output when handling 5/16-inch hex nuts is over 5000 nuts per minute or 25 boxes per minute with 100 per box (box transfer consumes half the cycle time). Each individual piece is counted by a photoelectric scanning head and an electronic counter, in changeable quantities from 1 up to 1000; 10,000 or 100,000 per box. Accuracy of count is accomplished by a trickle flow feature just prior to reaching the final count, permitting accurate feeder discharge cutoff. Machine operates on 110 v, 60 cycle single phase current, and requires 85 psi compressed air. **Batchelder Engineering Co. Inc.,** 125 Main St., Springfield, Vt.

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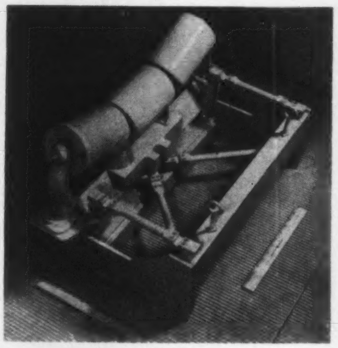
Conveyor Scale

Item 424

Electronic conveyor scale can be mounted between strands of any



standard flat or troughed belt conveyor from 14 to 72 inches in width. It is suitable for use in simple weighing processes, proportioning, feeding, and physical sampling systems. An electrical transducer converts instantaneous load weight into proportional voltages for continuous integration and digital display. A flexible, wishbone-type assembly restrains the scale idler in horizontal movement, permitting only vertical weight displacements to be measured. **Bell Automation Corp.**, 125 College Ave., Rochester 7, N. Y.

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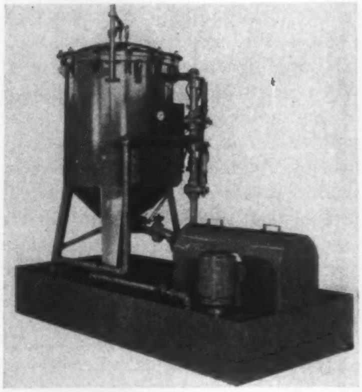

Coolant Filter

Item 425

Automatic pressure-type filter is capable of cleaning cutting oils, coolants, and lubricants. It is available in sizes ranging in capacity from 600 to 10,000 gph. The filter can remove 95 per cent (by volume) of suspended solids from petroleum or water base fluids. When using grinding wheel swarf as a precoat for the tubular Monel metal filtering elements, chips, dirt, scale, and other particles down to 3 micron size can be filtered out. When the elements are coated with an additive, ½ micron filtration is possible. Unit is self-cleaning and produces a continuous flow of clean filtrate even during the periods when the filters are cleaning themselves.

The filter renews itself by backwashing, after which the filters are automatically precoated. Backwashing and precoating are regulated in two ways: At preselected intervals from 30 minutes to 24 hours, set by a timer; or fully automatic on demand determined by back pressure in the filter. A perforated sludge receiver for oil applications is included in the filter. This receiver permits draining the oil and recirculating it through the system. **Olson Filtration Engineers, Div., American Laundry Machinery Co.**, 5024 Section Ave., Cincinnati 12, Ohio.

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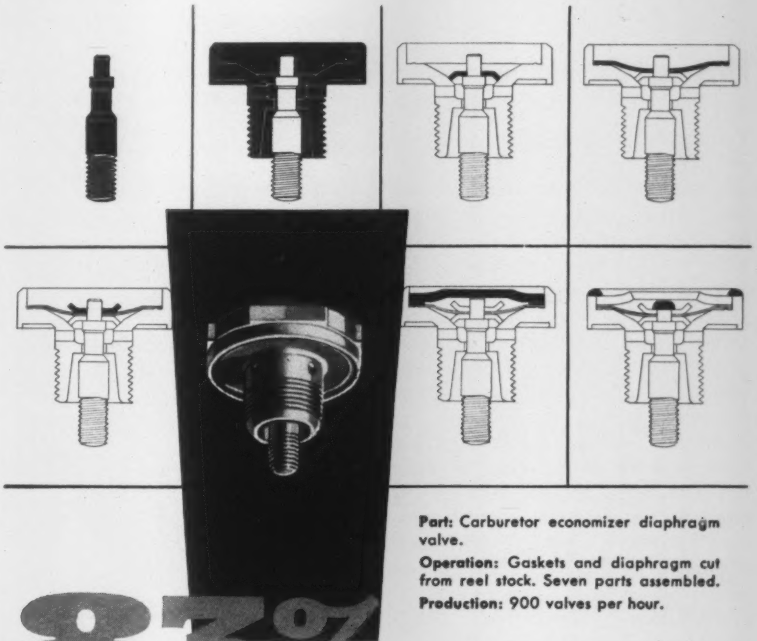
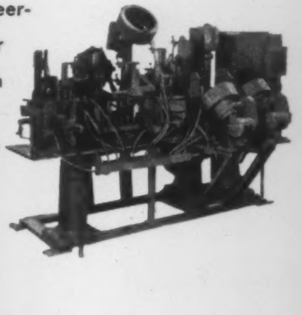


Part: Carburetor economizer diaphragm valve.
Operation: Gaskets and diaphragm cut from reel stock. Seven parts assembled.
Production: 900 valves per hour.

83% labor savings with automated assembly!

Can you automate your assembly operation economically? Gray's engineering staff is best equipped to answer your question. Design, manufacture, installation and initial operation of automated assembly equipment is our only business.



Write for our 24 page bulletin, "Automated Assembly."

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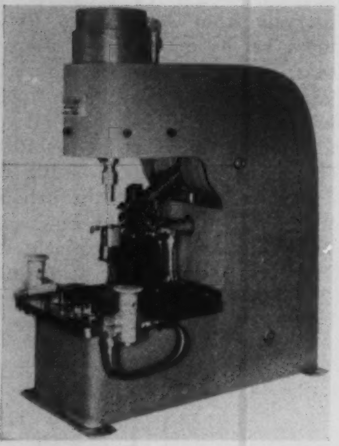
Circle 685 on Page 17



Fastener Assembler

Item 426

Integral feed unit has a gentle oscillating action, can feed fastening devices such as screws, nuts, bolts, rivets, and nails. Parts are oriented in an inner track and fed to an outer track for use in assembly operations. For special applications, dual tracks can be provided to feed and stake or assemble two parts simultaneously into one assembly. The machine can be equipped with a solenoid, air, or hydraulic powered driver which is used to drive, peen, press, or stake the part being fed into the assembly. Air or electrical controls provide automatic cycling. For semiautomatic cycling, unit can be operated with hand or foot valves. **Haberstump - Harris Inc.,** 10463 Northlawn Ave., Detroit 4, Mich.

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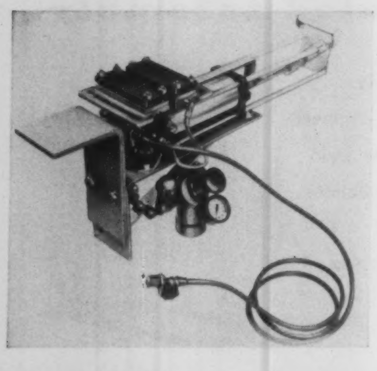

Press Feeder

Item 427

When attached to punch presses, air-operated stock feed will automatically feed strip or coil stock. Air consumption is held to a minimum by means of a power adjustment. A feature of the feed is a valve which opens the stock grippers for accurate loading, and aligning of the stock. With additional controls, the gripper can be set to synchronize with progressive die operations. The stroke length is adjusted by a feed control stop. Feed accuracy can be held to ±0.002-inch. The feeder is furnished in four models, with 4-inch wide by 13 gage and 6-inch wide by 13 gage capacities. Nonmetallic grippers can be substituted for steel when surface finish must be protected. Feed lengths are adjustable from a minimum of ¼-inch to a maximum of 8 inches. **Cleveland Pneumatic Industries Inc.,** 64 Old Orchard, Skokie, Ill.

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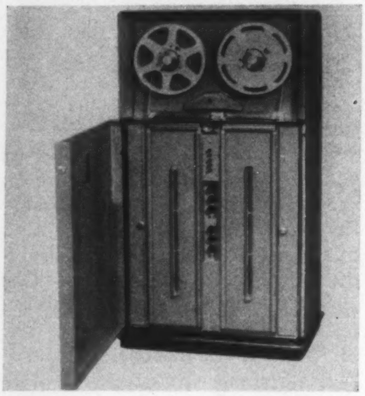
Acid Etcher

Item 428

Unit is capable of performing stream etching, quenching, and first-rinse operations on standard glass diode "first seals." Model E-302 (shown) consists of a 12-station indexing wheel with an array of 9 ball-socketed jet nozzles mounted in a tank. The manifolds and tubing connections are below water level. The index mechanism, mounted beneath the tank, is controlled by an adjustable timer. Nine of the 12 index positions can be used for jets capable of handling all acids including hydrofluoric and nitric. After the first-rinse operation, if additional rinsing is required, it can be performed before final bake-out. The etcher can handle between 1200 and 2400 parts per hour, depending on the etching cycle and loading rate. Another style, Model E-102, has two jet nozzles per station, can be used for etching rectifiers and transistors. **Carman Laboratories Inc.,** P. O. Box 328, Bedford, Mass.

Circle 428 on Page 17



Tape Reader

Item 429

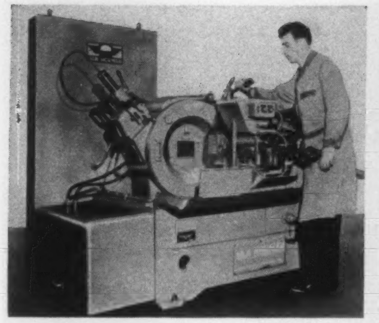
Model TR7 can read 5, 7, or 8 level tape at speeds up to 1000 characters per second. Rewind time is less than 30 seconds for 1200 feet of tape. Unit includes spooling, photosensing head, amplifiers, control circuits, and power supplies. It will operate under either computer or manual control. Feature of the tape reader is the built in checking facility. By means of a double row reading head each character on the tape is read twice. The readings are compared by a built in comparator circuit. **Electronics Div., Ferranti Electric Inc.,** 95 Madison Ave., Hempstead, L. I., N. Y.

Circle 429 on Page 17

Drill Grinder

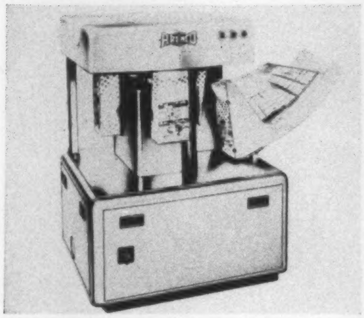
Item 430

Unit, designated Model 2-C, has a 24 by 8 by 12 inch grinding wheel. One person can operate three units simultaneously to turn out 5000 ground drills per hour. Grinder holds diameter limits to ±0.00025-inch up to ¼-inch diameter and ±0.0005-inch from ¼ to ½-inch diameter. Drill blanks are first ground oversize 0.003 to 0.004-inch and are then finish ground on the machine. They are ground



with back taper on the twist cut but the shank remains parallel. Unit is adaptable to automatic hopper feeding and automatic unloading of straight shank drills. **Van Norman Industries Inc.**, 6 Church St., New York, N. Y.

Circle 430 on Page 17



Automatic Bag Feeder

Item 431

Designed for use with weighing and proportioning equipment, automatic bag feeder and opener can serve two machines at the same time. It is suitable for granulated products or light weight products. Types of bags which can be used include SOS, satchel bottom, square bags with gussets, and flat bags. Output speeds are up to 35 fills per minute. Storage capacity of the magazine is approximately 300 bags.

In operation, Model VUF automatically takes one bag at a time from the storage magazine by suction, opens and fixes it at Station 1, moves it to Station 2 where the bottom is opened by compressed air, and then moves it to Station 3 where filling takes place. Then the filled bag is released to the conveyor line or sealing machine. **Arenco Machine Co.**, 25 W. 43rd St., New York, N. Y.

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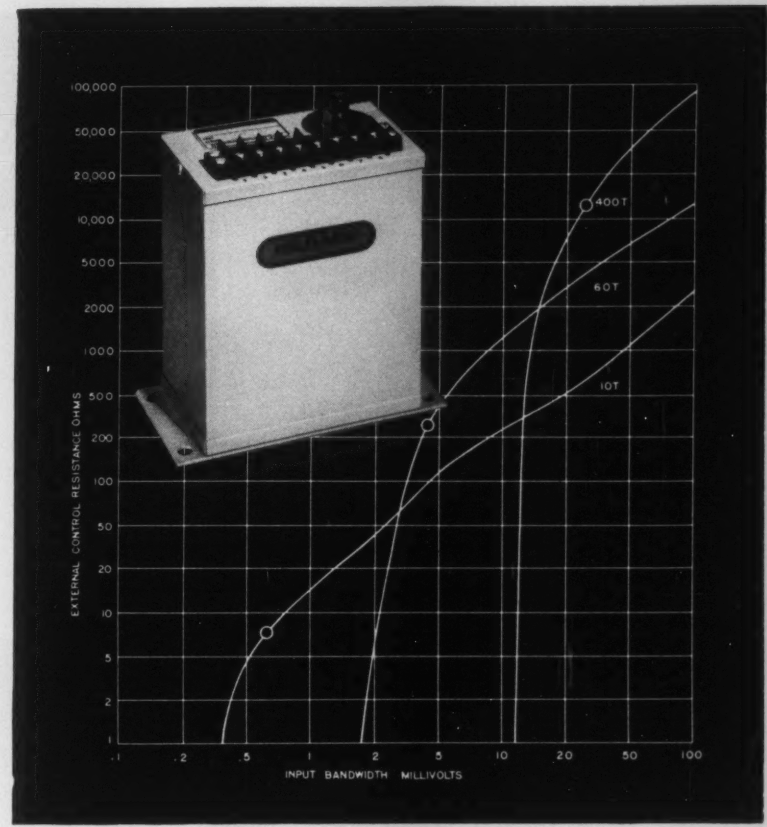


NEW WESTINGHOUSE BISTABLE AMPLIFIER

Ultra-Sensitive On-Off Static Amplifier

BISTABLE AMPLIFIER combines magnetic and transistor circuitry for an input sensitivity of 5 x 10^{-8} watts a-c or d-c. The output power is 6 watts at 24 volts d-c. This output is sufficient to drive auxiliary relays or static power amplifiers.

For current-control problems or voltage regulation, check these Bistable features:

- No tubes . . . no moving parts . . . no maintenance
- Exceptional sensitivity, 5 x 10^{-8} watts
- Multiple control windings
- A-C or d-c input signals
- Fast response . . . 20 milliseconds
- Economical . . . less expensive than relays
- Military versions available

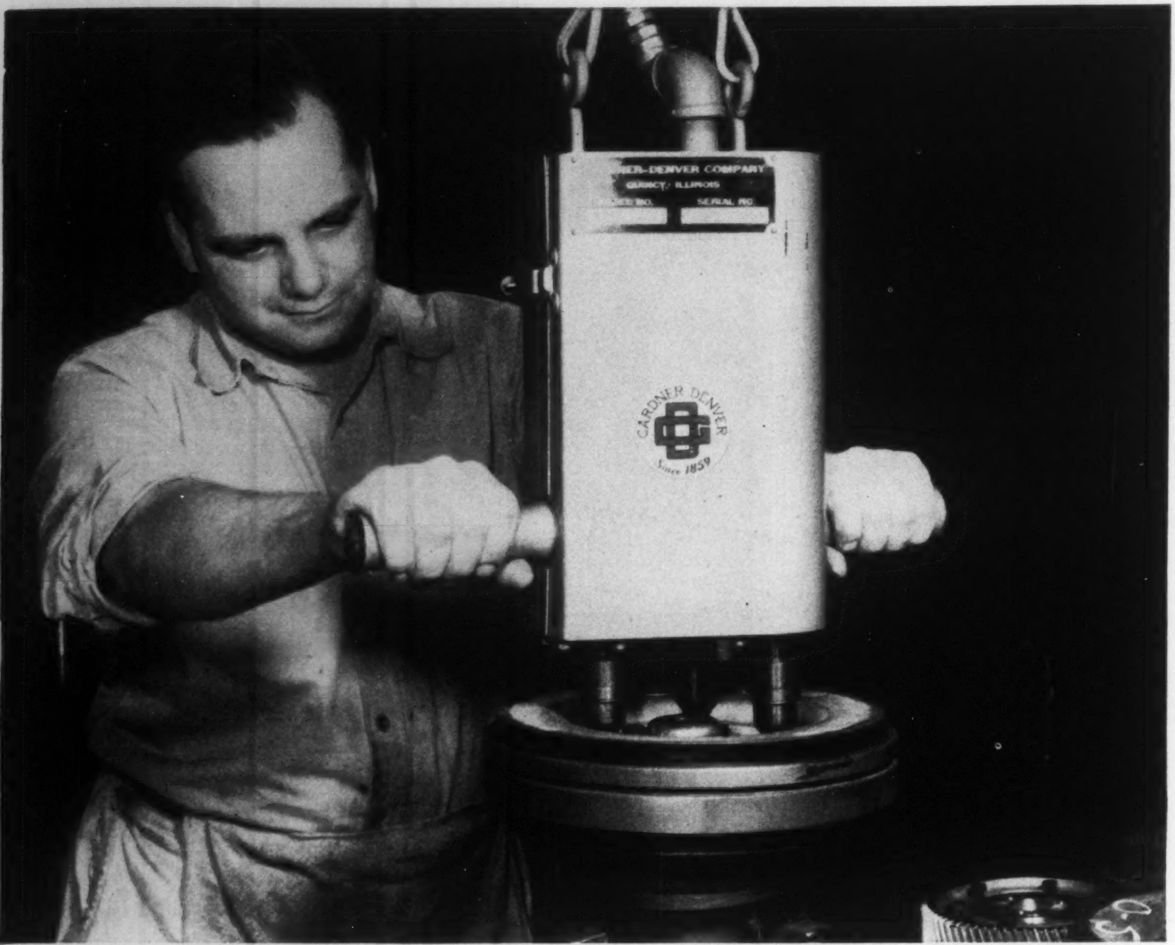
GET ALL THE FACTS: Write Westinghouse Electric Corporation, Director Systems Department, 356 Collins Avenue, Pittsburgh 6, Pennsylvania. Complete information on the new Westinghouse Bistable will be sent to you by return mail.

J-01009

YOU CAN BE SURE...IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS

Circle 686 on Page 17



In two passes this Gardner-Denver 3-spindle multiple nut setter tightens six bolts on diesel engine flywheel.

Check this special multiple design for fast, accurate nut running

A CONSCIENCE FOR QUALITY

Gardner-Denver equipment at work throughout the world has the conscience of Gardner-Denver men behind it: designers, engineers, metallurgists, instructors, servicemen. To these men there's no substitute for quality, as at Gardner-Denver there's no substitute for men—our 100-year philosophy of growth.

Speed production, control torque with air-powered multiple nut setters—designed to do the job by Gardner-Denver. Motor units, throttle handle, dead handle, manifold—all components are specifically designed for fast, accurate multiple nut running. And all components are standardized units that can be assembled to any combination to run any number of nuts, with each nut tightened to specified torque—*all in a single operation.* Switching from job to job is quick and easy. When the bolt pattern changes, simply move the standard spindles and handles to a new job-tailored mounting plate.

Whatever your production setup—from high-volume assembly lines to low production runs—Gardner-Denver multiple nut setters speed the job . . . cut time and costs. Contact your Gardner-Denver representative for complete information.

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100 1959 YEARS

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

Circle 687 on Page 17

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card page 17.

Computer-Controller Senses Zero Slopes

COMBINATION computer and logical controller is designed to control on the slope of the characteristic curves of the process rather than a fixed point such as a temperature. Unit, designated Maximizer, is made by **Quarie Controllers**, 381 N. Main St., Sharon, Mass. Some of the applications are: Controlling for the maximum or the minimum of some variable; controlling for stability, and maintaining a set-point under conditions of long process lag before a measurement can be made. When controlling for the maximum or the minimum of some variable, it could be the most product from a catalytic reaction, the maximum heat from fuel in a boiler, or holding minimum conductivity in the mixing of two flow streams. Other applications for which the controller can be used are: Holding a maximum or minimum conductivity or viscosity; maximizing product in a reaction, and stabilizing both binary and multiple product separation columns. It can also be used in material handling and mechanical systems, for example, to hold product thickness in a long dead time calendering process.

Operation of Model 760 is on a prediction principle wherein the control action is based on what the process is supposed to do after a change. This design allows stepwise changes in the process input to be automatically varied in size over a wide range, and because these steps decrease to zero as the maximum is approached, the control action is stable at the maximum. Control action is straightforward. An experimental change is made in the process input and the process is allowed to stabilize. If the change is for the better another change is made in the same direction—if it is worse, future changes are made in the opposite direction. If there is no process output change for the input change, then the slope is zero, the maximum has been achieved, and the control action stabilizes.

There are four styles in the line—the newest is Model 760-W which controls only for zero slope; a choice of a maximum or minimum. Input for this model is a dc mv signal with adjustable sensitivity. Suppression of the input signal is automatic over the range from −50 to 90 mv. Output is a modulated time signal with up to 100 w of power available to the process input change mechanism. Process stabilization times accomodated are adjustable over any ten to one range with a 30 second minimum.

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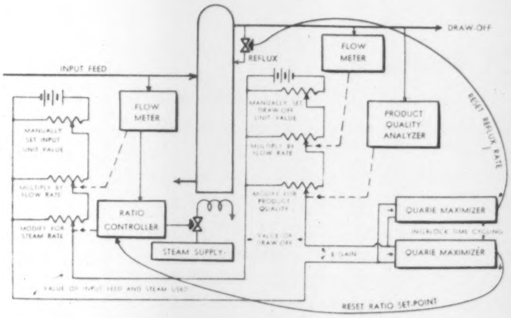
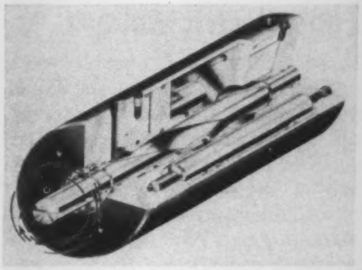

DRAW-OFF
REFLUX
FLOW METER
INPUT FEED
FLOW METER
MANUALLY SET DRAW OFF UNIT VALUE
PRODUCT QUALITY ANALYZER
RESET REFLUX RATE
MANUALLY SET INPUT UNIT VALUE
MULTIPLY BY FLOW RATE
MULTIPLY BY FLOW RATE
MODIFY FOR PRODUCT QUALITY
QUARIE MAXIMIZER
INTERLOCK TIME CYCLING
MODIFY FOR STEAM RATE
RATIO CONTROLLER
VALUE OF DRAW OFF
QUARIE MAXIMIZER
STEAM SUPPLY
$ GAIN
VALUE OF INPUT FEED AND STEAM USED
RESET RATIO SET-POINT

Two computer-controllers maximize process efficiency on basis of heat input, product output, and quality.



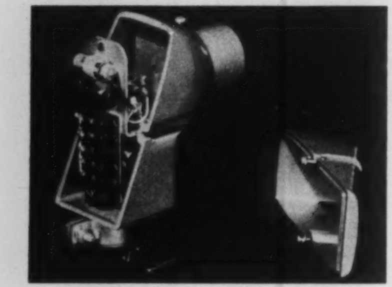
Rotary Torque Actuator

Item 433

Self-contained torque motor delivers high torque rotation from zero to 370 degrees in both directions through the use of a fluid power piston that slides over a rod and rotates it by acting on a helix on the rod. It is applicable for numerous types of positioning, indexing, cam actions, valve operations, swing motions, progressive turning, agitation, transfer mechanisms, dumping, clamping, rolling, and lifting. Actuator can deliver controlled torque from near zero to 15,000 lb-in. with pressures of 5 to 300 psi. A feature of the actuator is the helix design which provides a tight seal between piston and rod and incorporates a shielded antifriction thrust bearing. There is no internal piston by-pass leakage or external pressure loss.

Unit can be powered by air, gas, water, or oil. Full cushioning provides controlled deceleration at the end of either the clockwise or counterclockwise rotation cycle. This design provides an extra five degrees of rotation at the end of either cycle. Standard cycles are zero to 100 degrees, zero to 190 degrees, zero to 280 degrees, and zero to 370 degrees. Bore sizes available are 4, 5, 6, 8, 10, and 12 inches. **Carter Controls Inc.**, 2977 Bernice Rd., Lansing, Ill.

Circle 433 on Page 17



Photoelectric Relay

Item 434

Unit features a cadmium sulfide power cell, is suitable for indoor use on limit switch type applications such as conveyor lines, doors, and loading devices where the breaking of a light beam can be used to perform a job. The output relay is operated directly by the cadmium sulfide power cell. The relay draws its operating power of 57.5 v from the transformer which supplies power to the light source. Operating speed is a maximum of 200 operations per minute at a minimum illumination level of 25 ft-c. Life of the unit is rated over 100 million operations. **General Electric Co.**, Schenectady 5, N. Y.

Circle 434 on Page 17

Function Generator

Item 435

Instrument, designated Data-Trak, can translate into proportional electrical signals the process control or computer programming instructions that are fed to it in the form of a double pencil-drawn curve on standard graph paper. Some of the processes which can be controlled are temperature, pressure, speed, and position. The illustration shows a three-channel function generator which can simultaneously read three charts mounted on separate revolving drums. Under each drum is a probe or stylus that is servo driven to a null position midway between the two pencil lines that define the plotted function. A precision potentiometer is geared to each stylus servo so the slider always bears a position relationship to the plotted function. Self-contained unit will operate on 115 v, 60 cycle. **Research Inc.**, 115 N. Buchanan, Hopkins, Minn.

Circle 435 on Page 17

DC Motor

Item 436

Line of dc motors is available in ratings of 1 to 200 hp, in dripproof and dripproof guarded enclosures. They can be used to supply constant or adjustable speed for driving machine tools, metal rolling, drawing or forming machines, cranes, hoists, and conveyors. Motor, designated Flexitorq, incorporates an insulation which permits intermittent high overloads without damage to the insulation system. Other features of the motor include: Quick-release latches which secure the wrap-around cover that protects commutating brushes and brushholders; and low inertia brush springs that provide correct pressure without readjustment during the brush life. **Louis Allis Co.**, Dept. P, 427 E. Stewart St., Milwaukee 1, Wis.

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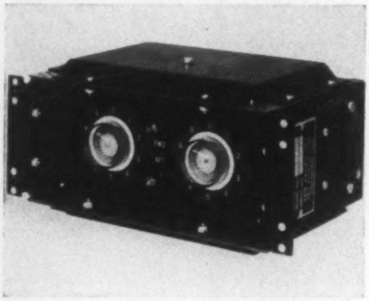

Digital Timer

Item 437

Portable, transistorized digital interval timer is applicable for actuator, valve and relay timing, and time sequence indication. It can accurately measure a time interval and indicate which of two arbitrary signals started the interval. Model 2202TL has pluggable decades and printed circuit cards. The cards are mounted in hinged sockets and swing outward for easy access to the board components and interior of the counter. Time intervals are measured to the nearest 0.1 millisecond for a total indicated time of 9.9 milliseconds (2 decades) or 99.9 milliseconds (3 decades). Start and stop signals in the form of contact closures or 10 v pulses are applied to separate inputs.

A temperature compensated 10 kc crystal controlled oscillator provides the reference frequency which is gated to the counting unit. The gate is controlled by a transistor flip-flop which is triggered by transistor avalanche diodes at the start and stop inputs. **Erie-Pacific, Div., Erie Resistor Corp.**, 12932 S. Weber Way, Hawthorne, Calif.

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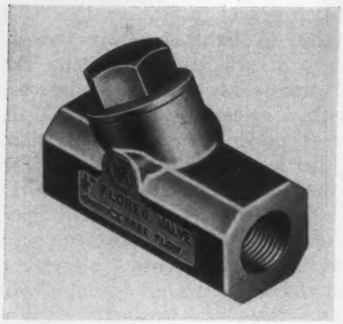

Flow Control Valve

Item 438

Adjustable valve can be used with other components of a fluid circuit to time, sequence, or co-ordinate the operations of the circuit. It controls the rate at which a gas or a liquid can flow in one direction through the circuit, yet allows free flow in the opposite direction. Some of the applications of the valve are: In the delivery line to a cylinder to control its piston speed; in material processing to time operations; or in material handling to co-ordinate movements. Working pressure of the valve is 250 psi maximum pneumatic, 500 or 2000 psi maximum hydraulic. Operating temperature range is −40 to +200 F. **Industrial Products Div., Westinghouse Air Brake Co.**, P. O. Box 36, Wilmerding, Pa.

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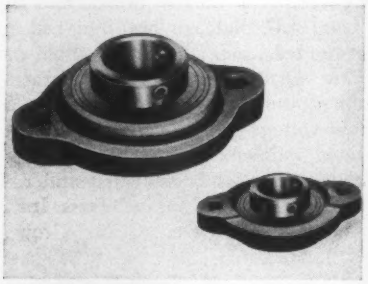

Flanged Bearings

Item 439

Design of the housing of two-bolt and three-bolt flange bearing units permits either flush or recessed mounting. It also provides full housing contact under bearing ball path. Self-alignment automatically takes place between the spherical OD of the bearing and the spherical ID of the housing. Centrifugal-labyrinth seals retain the lubricant and prevent dirt from entering. Units are available in 10 sizes ranging from ¾ to 1 7/16-inch. **Sealmaster Bearing Div., Stephens-Adamson Mfg. Co.**, Ridgeway Ave., Aurora, Ill.

Circle 439 on Page 17

Adjustable Switch Arm

Item 440

Designed for use on heavy duty limit switches, adjustable arm improves applications on conveyors, machine tools, and different types of automatic equipment. The length of the arm can be varied to fit the different applications, permitting the switch to be mounted safely out of the path of moving pieces. The arm is comprised of three pieces. The roller portion fastens to a length of ¼-inch key stock, which in turn is inserted into the section fastened to the switch. **Square D Co.**, 4041 N. Richards St., Milwaukee 12, Wis.

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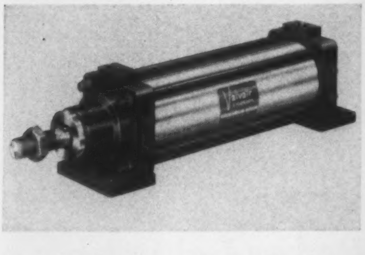
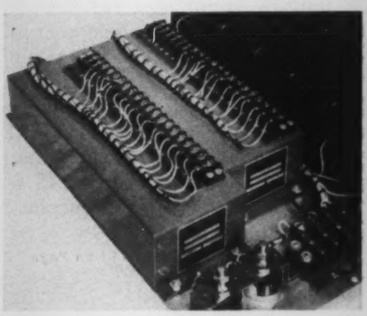


Air & Hydraulic Cylinders

Item 441

Line of heavy-duty and hydraulic cylinders features extra long bronze rod bearings, with length-to-rod diameter ratios of up to 2:1. The rod wiper and metallic-backed rod seal are installed in a removable cartridge; the seal cartridge can be replaced without partially disassembling the cylinder. A Teflon wear strip on the piston prevents metal-to-metal contact between the piston and bore, prevents scuffing or scoring of the bore surfaces, and lengthens the piston cup life. Removable cylinder port adapters permit replacement of the cylinder assembly without disturbing basic piping connections. Cylinders are built to JIC standards for 200 psi air and 500 psi hydraulic. Cylinders are available in a choice of six mounting styles, in a wide range of bore sizes, with stroke lengths to suit individual application requirements. **Valvair Corp.**, 454 Morgan Ave., Akron 11, Ohio.

Circle 441 on Page 17



Rectifier Control

Item 442

Magnetic rectifier control is capable of driving six silicon controlled rectifiers to furnish controlled power in a servo amplifier system. It can drive up to 1 hp two-phase ac motor from a 3-phase line. Model R87P2 is a packaged push-pull, push-push control unit which is made up of two sections. The first section is a full-wave, push-pull unit which will drive two sets of two controlled rectifiers and deliver either phase-reversible ac or polarity-reversible, full-wave rectified dc controlled power output. The second section of the unit is a full-wave, push-push designed to drive two controlled rectifiers in proportion to the magnitude of a dc control signal, independent of the polarity of the signal. Each section is available as a separate unit. **Fairfield Engineering Corp.**, 934 Hope St., Springdale, Conn.

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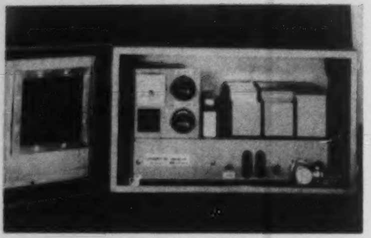

Flow Measuring System

Item 443

Electronic flow measuring system can monitor or control gas or liquid flow. System includes transducers (to measure pressure and temperature), a computer, integrator, and counter. Accumulated volume is registered on a mechanical counter. Differential pressure input is 4 per cent to 100 per cent for 100 per cent of static pressure. Static pressure input is 4 per cent to 100 per cent for 100 per cent of differential pressure. Maximum working pressure is dependent on transducers only. Speed of response is 3/100ths of a second for 63.2 per cent of full scale range. Input power is 95 to 120 v, 60 cps, 15 w. **Computers Inc.**, 3407 S. Shepherd Dr., Houston 6, Tex.

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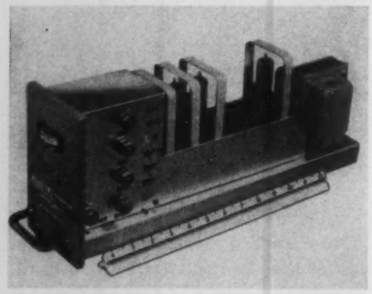

Servo Amplifier

Item 444

Applicable in electrohydraulic control systems, dc servo amplifier features over-all modular construction. The amplifier can be partially withdrawn from the panel for adjustment and checks while under full power. Further withdrawal disengages the unit for complete removal. Adjustments can be made for gain, zero, balance, dither, and feedback potentiometer excitation. Internal gain of Model SA-2002-P is greater than 60 ma/v; quiescent current for the differential output is 15 ma for loads up to 3 k; dither output is 350 cps. **Plug-in Instruments Inc.**, 1416 Lebanon Rd., Nashville, Tenn.

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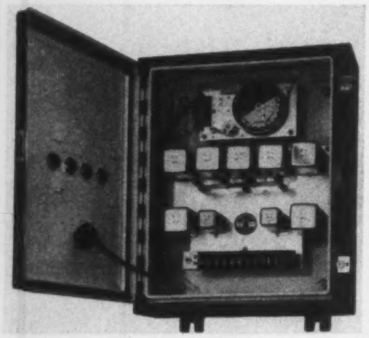

Pumping Control

Item 445

Automatic program timer control can be used on gas, gasoline, or diesel engines in oil wells, underpasses, and pipe line pumping. Control consists of an automatic engine control and a timer driven by a governed dc motor. With this control on an engine, it can be preset for *length of time, time of day*, and the *days of the week* that it is to run. No commercial power is needed for the operation of this unit, all current is taken from the engine battery. **Synchro-Start Products Inc.**, 8151 N. Ridgeway Ave., Skokie, Ill.

Circle 445 on Page 17

DENISON
LOXSWITCH

Machine Tool Switch

Item 446

Heavy-duty limit switch is constructed with all major friction points either nylon or oil impregnated bearings. It is furnished for direct wiring or as a plug-in style for easy replacement. Life of the switch is said to be over 45,000,000 cycles. A light actuating force of 45 oz in. will trip the switch. Trip differential is short (6 degrees), with a safety overtravel of 50 degrees provided in both directions. Other features of Model M are: Two completely isolated circuits, 600v industrial rating, one normally open, one normally closed; positive double break; and full contact pressure at all times. Switch is available with three different bases and five lever styles. **R. B. Denison Mfg. Co.**, 102 St. Clair Ave., N.W., Cleveland 13, Ohio.

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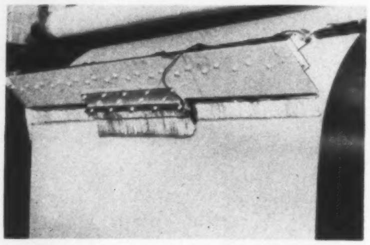

Flaw Detection Brush

Item 447

Applicable on paper, plastic, or rubber; flaw detection brush, when used with suitable electronic equipment, will send low voltage pulses to an indicating system which records the condition of the material under inspection. In operation, the nonconducting material is passed between the feeler brush and a metal roll, plate, or bar. The roll is grounded, and whenever a hole or flaw appears, the brush contacts the grounded roll and transmits a low voltage pulse to a remotely located indicator unit. The exact location of holes is indicated and recorded. **M. W. Jenkins' Sons Inc.**, 444 Pompton Ave., Cedar Grove, N. J.

Circle 447 on Page 17

Meter/Controller

Item 448

Self-contained, transistorized unit is designed to continuously control or limit an electrical variable. The transistorized control amplifier in the controller allows the use of an infinitesimal signal current (of the order of a millionth of an ampere) to control amperes in the complete system. The contact meter and controller can be separated from each other and located at remote points. **Waters Mfg. Inc.**, Wayland, Mass.

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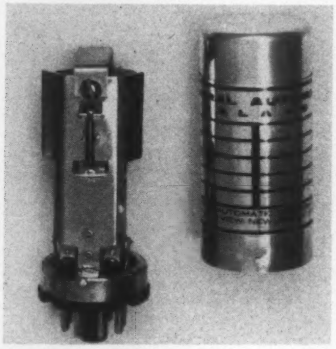

Dustproof Relay

Item 449

Sensitivity of dustproof relay can be as low as 2 milliwatts per contact in configurations from SPST to DPDT. The cover can be removed for inspection or adjustment of the relay. A screw on the armature spring can be adjustified with a screwdriver to modify pick-up characteristics, contact pressures, or power requirements. Unit can be adjusted with pick-up and drop-out ratios as high as 85 per cent or as low as 10 per cent. Standard coil resistances are up to 30,000 ohms and special windings to 100,000 ohms. Contact capacity ranges from 3 to 5 amps resistive depending on sensitivity. **General Automatic Corp.**, 12 Carlton Ave., Mountain View, Wayne, N. J.

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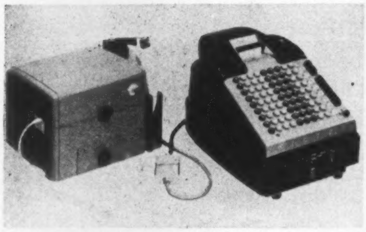
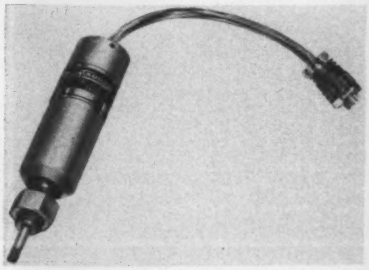


Tape Punching Adder

Item 450

Unit combines a full-keyboard adding machine and a tape punch. It is suitable for accounting, forecasting, planning, sales analysis, and inventory. The punch, which is activated by the adding machine, operates at a rate of 20 digits per second. Equipment produces two records simultaneously — a detail strip for immediate accounting data and a punched tape which can be directed to digital computers and processors. Information on the punched tape can be converted to punched cards or magnetic tape for further processing. Machine can produce 5, 6, 7, or 8-channel punch tape. **Victor Adding Machine Co.**, 3900 N. Rockwell St., Chicago 18, Ill.

Circle 450 on Page 17



Position Transducer

Item 451

Displacement transmitter provides an electrical output which is precisely proportional to displacement of its spring loaded plunger. Model 102A-120 can give linear motion measurement or gaging with accuracy to 0.0001-inch in ranges up to 0.120-inch. The transducer is an inductance device, has no sliding electrical contacts, and is relatively unaffected by mechanical shock, temperature, or atmospheric pollution. A threaded shank and lock nut allows secure and precise positioning in a mounting flange. **Daytronic Corp.**, 216 S. Main St., Dayton 2, Ohio.

Circle 451 on Page 17

Continuous Duty Motor

Item 452

Unit is suitable for use on high starting-torque applications in piston type pressure compressors, hoists, pumps, antenna drives, and hydraulic pumps. Motor will produce 4 hp at 3250 rpm, continuous duty. It is rated for 3 phase, 400 cycle, 200 v. Features of Model D-1260 are: Precision ground aircraft ball bearings, integral cooling fan, steel insert bearing liners, and high temperature windings. Straight drive version offer speeds of 5400 rpm, 7400 rpm, 11,500 rpm, and 22,000 rpm. **Hoover Electric Co.**, 2100 S. Stoner Ave., Los Angeles 25, Calif.

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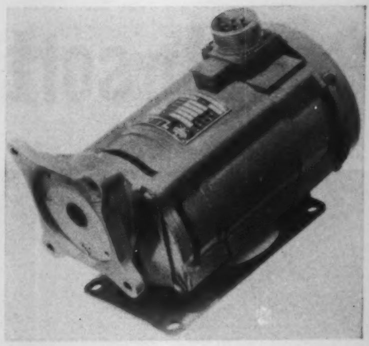
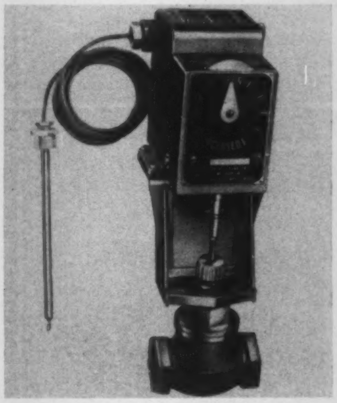




Temperature Regulator

Item 453

Single seat temperature regulator is adaptable for proportional control of water, gas, or low pressure steam on applications where a self-contained valve assembly is needed. No assembly, linkage, or adjustment is necessary after installation, except for setting the calibrated dial for precise temperature control.

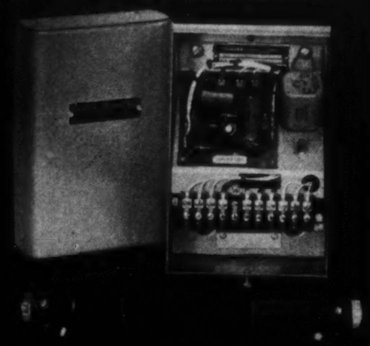
The valve body is a single seat, packed globe type, with V-port inner valve. It is available in a bronze body with bronze trim in sizes from $1/4$-inch to 2 inches or an iron body with bronze trim in larger sizes. Static pressure rating is 150 psi for bronze bodies; 125 psi for iron bodies with close-off (differential) pressure rating dependent on the valve size, limitation of composition disc, and valve linkage assembly. Unit will operate on 115

Count, sort, or inspect them faster

Self-contained relay

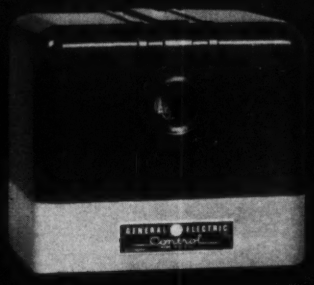
Low-cost; ideal for limit-switch-type application; includes a SP-DT output relay.

Transistorized relay



Features transistors; hermetically sealed plug-in relay; miniature light source, photocell holders.

General-purpose relay



A low-cost, highly reliable relay suited to counting, diverting, limiting and signalling jobs.

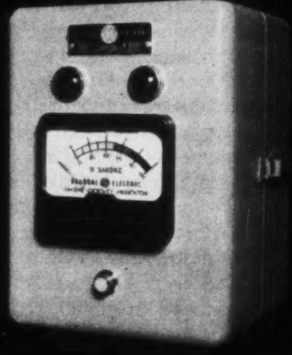
Explosion-proof relay

Watertight, explosion-proof; includes 3-inch lens, self-contained phototube, time delay.

Long-distance relay

Responsive *only* to light from accompanying light source; operates at distances up to 2,500 feet.

Smoke-density indicator

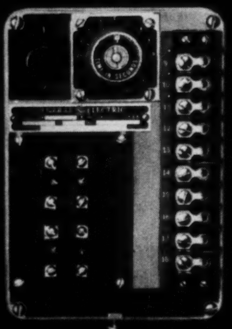


Measures smoke density, liquid turbidity, etc., and provides alarm when pre-set point is reached.

Voltage-sensitive relay

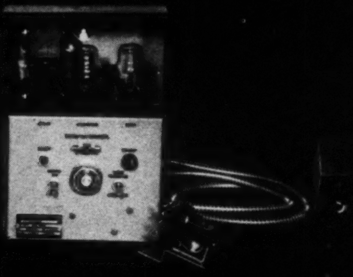
Detects voltage changes for meter operation, elevator-motor overspeed detection.

Electronic timer



Provides time delay of given duration, or set interval simply by setting dial at desired time.

Cut-off register control

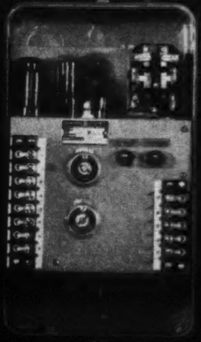


Low-cost; features direct operation of solenoid, small scanner, timed reset and relay kits.

and more efficiently with modern

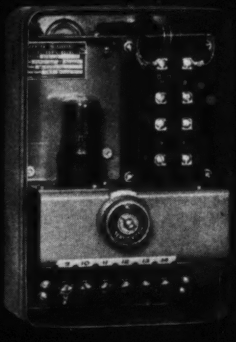
G-E electronic devices

High-speed relay



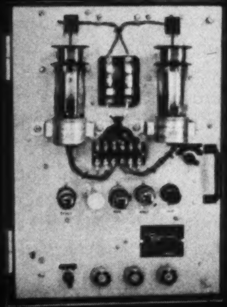
High-sensitivity; fast operating (600 ops. per min.); time delay, interlock, many other features.

Resistance-sensitive relay



Uses resistance changes to control a circuit; can operate motor to maintain liquid between two levels.

Side-register control



Accurately maintains lateral position of moving web in a process or machine; high-accuracy control.

Your General Electric distributor offers a full line of simple, easy-to-use controls

Whether you're automating a production line . . . replacing obsolete machines . . . or, trying to get more out of present equipment . . . one of General Electric's photoelectric or electronic controls may help you gain faster, more efficient production.

Why? Because G-E photoelectric and electronic control devices are specifically intended to take the complexity . . . the labor . . . and the waste out of modern-day production. Combinations of these devices are applicable to virtually any industrial counting, sorting, signalling, protecting, diverting, detecting, or limiting job. And, chances are they will do the job at less initial cost—and lower operating cost—than the control methods you are now using.

CONSIDER THESE EXTRA-VALUE FEATURES

Bonus features you get with job-proved General Electric photoelectric and electronic controls include:

Fast response—Relays operate on light changes as short as 1/1000th of a second.

Versatility—G-E relays operate on light increase, decrease, time delay, reflected light, slow or rapid light change.

Dependability—Lamps operate 3,000 hours or more. Components are conservatively rated for long, maintenance-free life.

If you are not satisfied with the efficiency of your production operations, it will pay you to find out about G.E.'s complete line of control devices. Call your nearby G-E Apparatus Sales Engineer or Distributor. Or, send us the coupon below. *General Electric Co., Specialty Control Dept., Waynesboro, Va.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 688 on Page 17

SEND TODAY FOR *FREE* CATALOG

General Electric Co., Section B793-1
Schenectady 5, N.Y.

Please send me a copy of the new G-E Photoelectric Control catalog, GEA-6822, with description, specifications, and pricing data on the complete line.

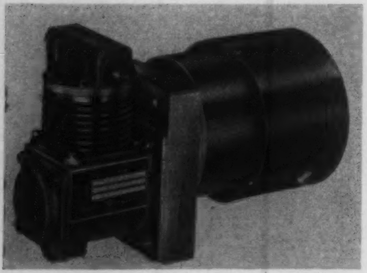
Name______________________________

Company______________________________

Address______________________________

City____________________ **State**__________ v, 60 cycle with a motor input of 28 w. **Barber-Colman Co.**, 1300 Rock St., Rockford, Ill.

Circle 453 on Page 17

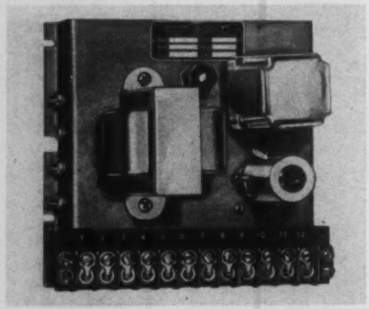


Oil-Free Air Pump

Item 454

Single piston air pump can be used to supply oil-free compressed air. Model 04-301 is designed for continuous or intermittent operation; features Graphitar and Teflon piston rings and prelubricated bearings. Capacity of the pump at 50 psig is 127 cu in. per minute. It is available with a 1/8 hp, 400-cycle motor, either single phase at 115 v or three phase at 200 v. **Applied Dynamics Corp.**, 32 N. Main St., Natick, Mass.

Circle 454 on Page 17

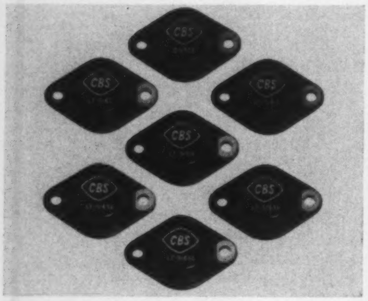


Pilot Relay

Item 455

Device is adaptable as a single or dual level control for liquids; high or low level alarm; a contact meter amplifier; a liquid leak detector, or a temperature detector. Model PR2 (shown) is tripped by sensing circuit resistances as high as 5 megohms. A low level probe current (10 microamp) controls the output relay. Dual mode connections permit selection of minimum tube *On* time for long tube life, and provide normally energized or normally de-energized relay operation. Two SPDT, 5 amp, 110 v load contacts are provided. No special cables are required for distances up to 50 ft. Another relay (Model PR1) is tripped by sensing contacts with as high as 5000 ohms contact resistance, or by closure of a circuit in liquids with less than 5000 ohm path resistance. The output relay contacts are SPDT rated 20 amps at 110 v. **Webster Electric Co.**, Racine, Wis.

Circle 455 on Page 17

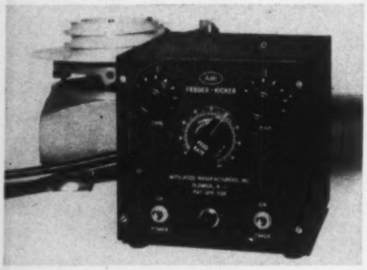


Power Transistors

Item 456

Line of power transistors can be used in complementary push-pull or cascade circuits. They can also be used for single-ended cascade output circuits. Three of the transistors in the line are designed for use with inductive loads such as output transformers, motors, and relays. Features of the transistors are: High collector voltage (up to 89 v), a maximum collector current of 2 amp, and a minimum cutoff frequency of 150 kc. **CBS-Hytron**, Parker Street, Newburyport, Mass.

Circle 456 on Page 17



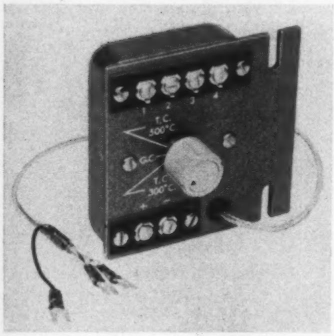
Feeder Control

Item 457

Electronic device improves the feeding of small and subminiature parts by electrically driven vibratory feeders. Unit, designated the Kicker, continually breaks up jams or inertia which can result from the presence of dirt, dust, vapor film or static electricity. Action is based on automatically timed and adjustable energy impulses that jar the parts into movement. These impulses are adjustable from 5 seconds to 60 seconds and in varying degrees of energy output as required by the types of pieces being fed.

By means of this electronic device, feeding speeds as slow as one per minute can be obtained. Normal feeding speeds are 200 to 300 per minute. Model C-1 can be used for any shape or part made from metal, glass, compressed powder, or plastic in sizes ranging from 0.004 to 0.5 inches. The self-contained unit will operate in conjunction with feeders operating between 0.6 amp to 1.2 amp on 115v, 50 or 60 cycle power. **Affiliated Manufacturers Inc.**, Oldwick, N. J.

Circle 457 on Page 17

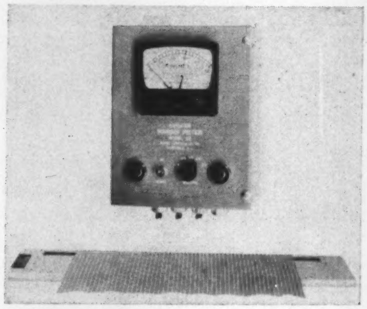


Temperature Recorder

Item 458

Accessory is designed for gas chromatographs for recording column or sample inlet temperatures directly on gas chromatograph charts. It can be installed on one-millivolt recorders to provide rapid selection of normal gas chromatograph detector readout or either of two temperature measuring circuits. Unit includes a switch box and two iron-constantan thermocouples; one for use as a reference and the other for sample compartment temperature readout. **Scientific & Process Instruments Div., Beckman Inc.**, 2500 Fullerton Rd., Fullerton, Calif.

Circle 458 on Page 17

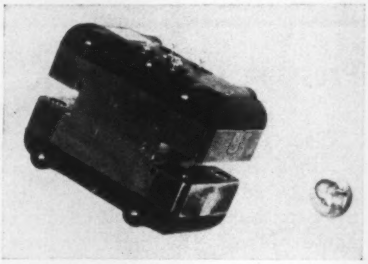


Width Gage

Item 459

Applicable in the textile, paper, and plastic film industries; electrical device is designed to give automatic, continuous width measurement without machine interruptions. Instrument consists of a measuring unit and indicator. Before the unit starts, an operator sets an edge allowance dial and two tolerance pointers. In operation, as the material moves over the measuring unit, the indicator gives an instantaneous width reading. It is insensitive to side-slip and if the width should exceed either the high or low tolerance setting a flashing red light or audible alarm is actuated. Device will operate on 115 v ac. An available accessory is a recorder which can print a continuous width record. **Matrix Controls Co. Inc.,** P.O. Box 22, Somerville, N. J.

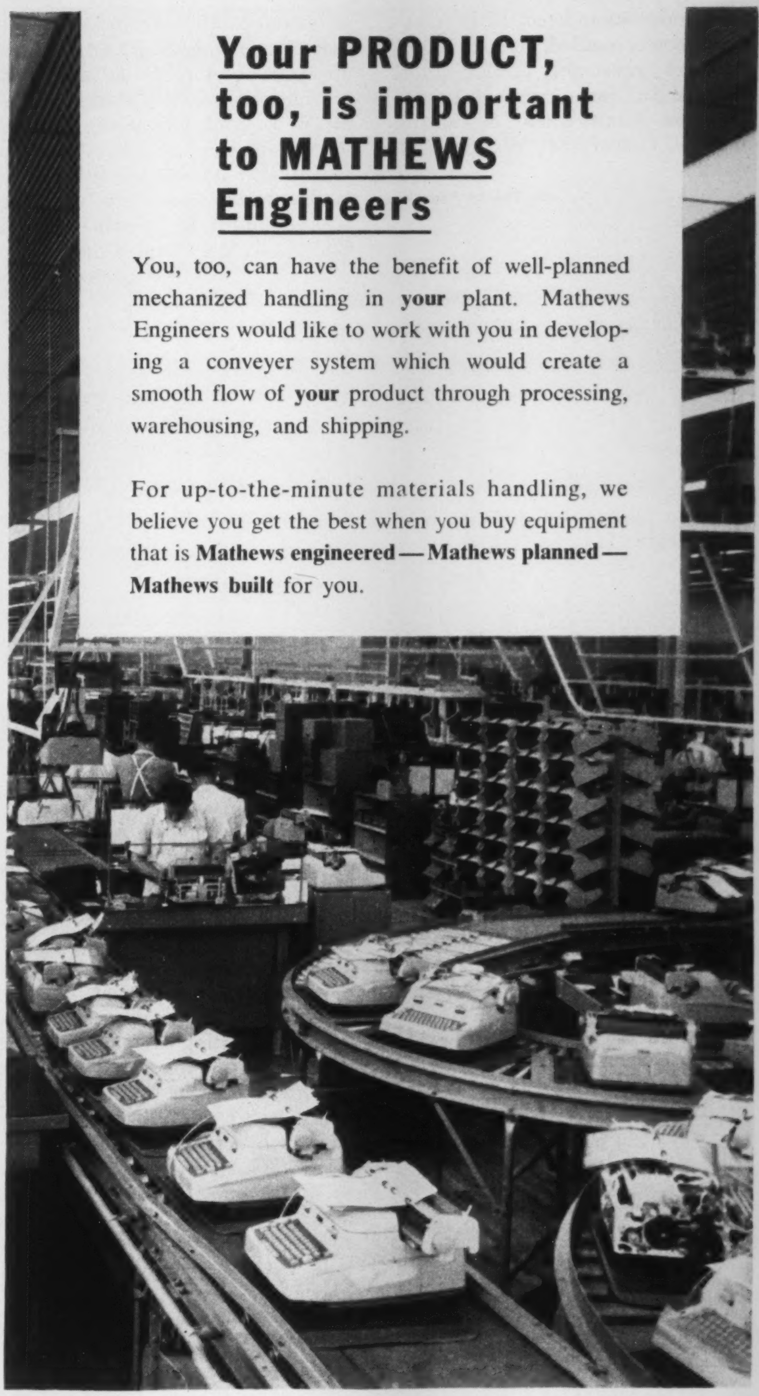
Circle 459 on Page 17



Torque Motor

Item 460

Electromechanical transducer can be used as an actuator of hydraulic servovalves, or in servo-controlled machine tools and process-control systems. It is applicable wherever a small amount of electrical power must produce a substantial force or displacement which is proportional to the input current. Specifications for Model 106 are: Stroke, ±0.020



Your PRODUCT, too, is important to MATHEWS Engineers

You, too, can have the benefit of well-planned mechanized handling in **your** plant. Mathews Engineers would like to work with you in developing a conveyer system which would create a smooth flow of **your** product through processing, warehousing, and shipping.

For up-to-the-minute materials handling, we believe you get the best when you buy equipment that is **Mathews engineered — Mathews planned — Mathews built** for you.

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CANADIAN DIVISION . MATHEWS CONVEYER COMPANY, LTD., PORT HOPE, ONTARIO.

MCC

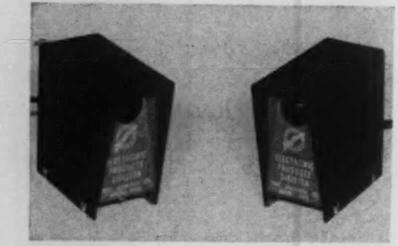
MATHEWS

Over Fifty Years of Leadership in Mechanized Handling

Circle 689 on Page 17

inch; midposition force, 15 lb; maximum power needed, 4.5 w; standard coil resistance, 2600 ohms; standard full-force current, 40 ma. **American Measurement & Control Inc.**, 240 Calvary St., Waltham 54, Mass.

Circle 460 on Page 17

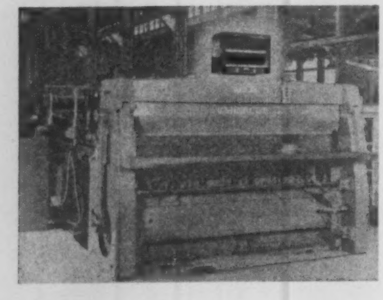


Photoelectric Control

Item 461

Multipurpose electronic control, designated Decitron, features a hermetically sealed solid state photocell and a single pole, double throw relay (dc operated). A sensitivity control provides for operation over a wide range of ambient light levels. The light source and receiver are individually mounted. Model K-5 senses up to 1000 interruptions per minute, can be used as an *On-Off, Go-No-Go* control. Unit will operate on 115 v, 50/60 cycles, light source consumes 12 watts with 3 cp bulb. **Electronic Products Div., Post Machinery Co.**, 151 Elliott St., Beverly, Mass.

Circle 461 on Page 17



Trimmer Spacer

Item 462

Electronic automatic spacer for guillotine trimmers can be used on any trimmer that has a screw operated back gage. Up to 20 different settings can be provided, in increments of 1/64ths from 2 to 100 inches or more. Trimming is done by turning lifts 90 degrees each time. A foot controlled switch moves the gage backwards at any time providing room for turning large lifts or moves it forward to push the lift toward the operator. When the switch is released, the back gage automatically moves to the next setting. **Smith & Winchester Mfg. Co.**, South Windham, Conn.

Circle 462 on Page 17

Electronic Tachometer

Item 463

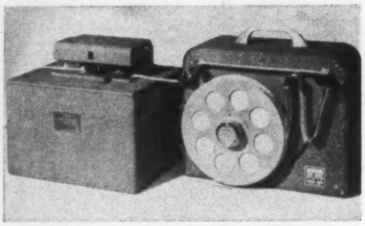
Self-contained unit can accurately measure the speed of any rotating, reciprocating, or oscillating shaft or mechanism. The unit, designated Tach-Pak, employs a combination of transistor and magnetic circuits. These frequency sensitive circuits convert a signal frequency from a magnetic pickup into a current output which may be read directly on a meter scale calibrated in rpm. This current is directly proportional to the actuating frequency generated by the motion of a gear, shaft, or other rotating system component. Input signals no greater than 5 mv will operate the unit. A zero to 5 v output drives loads as high as 3000 ohms. Output voltage is directly proportional to speed or rpm of the device measured. **Seminole Div., Airpax Electronics Inc.**, Fort Lauderdale, Fla.

Circle 463 on Page 17

Tape Reader

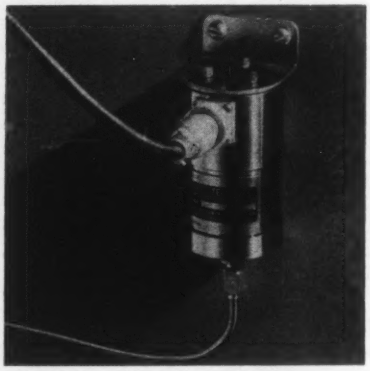
Item 464

Self-contained photoelectric tape reader can operate at speeds up to 330 characters per second. It will accept 5, 7, or 8-hole tape widths. Model TR5 uses a photoelectric system of reading. Light from a festoon lamp is focused by a lens onto the tape. Underneath the tape is a single silicon crystal with 9 photo-



sensitive elements. The output from each of these elements is connected to plug-in printed circuits on which the information is stored in transistor flip-flops. The output signal level of the flip-flops changes from +0.05 v to −5 v. By means of connecting links, either polarity of output can be selected. The only inputs required to operate the unit are 115 v, 60 cps, and 2 v control signals from the unit to which data are being fed. **Electronics Div., Ferranti Electric Inc.**, 95 Madison Ave., Hempstead, L. I., N. Y.

Circle 464 on Page 17



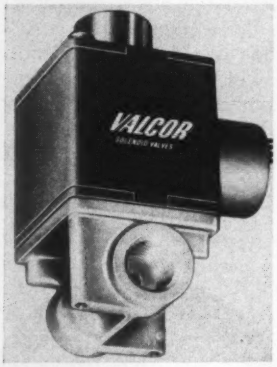
Pressure Transducer

Item 465

Electrical pressure transducer has a high frequency response, can measure dynamic pressures like those encountered in the testing of power plants, hydraulic systems, and high speed chemical reactions. Corrosive gas and liquid pressure up to 200 psi can be measured.

The electrical sensing element consists of a sensitive proving ring type spring element with 4 precision strain gages bonded to its circumference. When pressure is applied to the element a linear resistance change occurs proportional to the applied pressure. The resultant output signal is used to actuate indicators, meters, oscilloscopes, recorders, controllers, and electronic computers which are used in pressure measurement systems. Resolution of Model 217 is infinite; linearity 0.3 per cent; hysteresis 0.25 per cent; repeatability 0.1 per cent; ambient temperature −150 to 250 F. **Taber Instrument Corp.**, N. Tonawanda, N. Y.

Circle 465 on Page 17

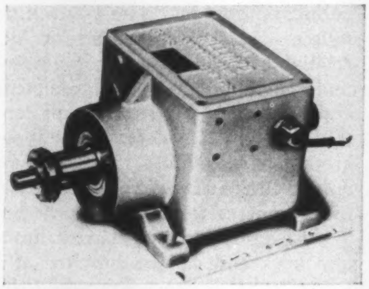


Solenoid Valve

Item 466

Shock-resistant, pressure-proof, 3-way valve has a nylon body. The nylon is noncorrosive and the hard chrome-plated plunger is said to be good for millions of cycles. Valve has bubble-tight sealing, is available for normally open, normally closed, and directional control operation. **Valcor Engineering Corp.**, 365 Carnegie Ave., Kenilworth, N. J.

Circle 466 on Page 17

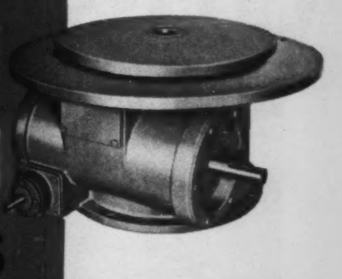


Intermittent Drive

Item 467

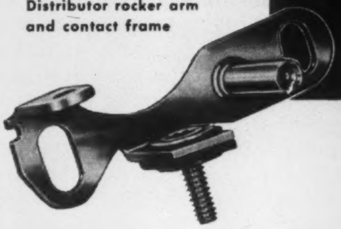
Packaged unit can provide precise intermittent motion from a constant source of rotary power. All parts are totally enclosed in an oil bath housing suitable for dusty, steamed, or wash-down conditions. The building-block unit can easily be installed on existing equipment, or

HIGH SPEED ASSEMBLY with Standard Tool Indexing Units



Typical 12 position Model ST-A9 Indexing Unit with precision shot pin locating

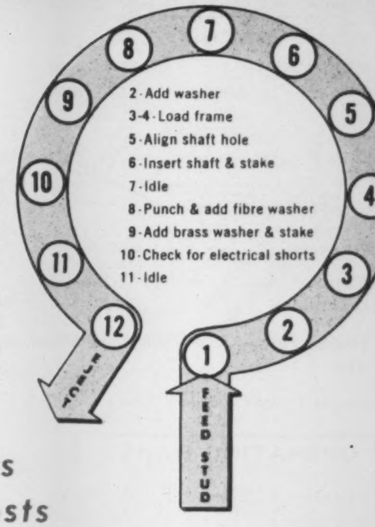
Floyd Lyon, Vice President of the Halm Instrument Company, Inc., says:
"We have had fine service experience and virtually no maintenance with Standard Tool indexing units—We have many in service over four years without fault."



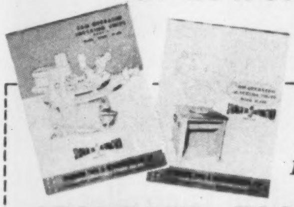
Distributor rocker arm and contact frame

● At the right is illustrated the operations performed on a recently designed Halm high speed assembly machine. All working units at index stations are cam operated from the index unit cam shaft.

Standard Tool Indexing Units, "The Heart of Automatic Machines" are available in many sizes and types to solve most automatic production problems.



Better Products at Lower Costs thru Better Methods!



Technical Booklets Sent on Request!

Standard Tool engineers will be pleased to help you in selecting the indexing unit to meet your exact requirements.
Also ask for Standard Tool facilities brochure.

STANDARD TOOL & MANUFACTURING CO.

242 LAUREL AVENUE
KEARNY, NEW JERSEY

STANDARD TOOL AUTOMATION

Since 1910

Circle 690 on Page 17

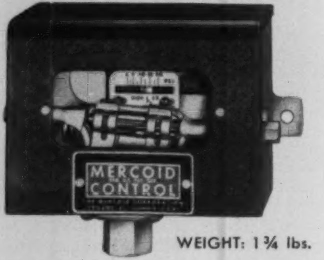
NEW

Small, Lightweight

MERCOID

PRESSURE CONTROL

AP-153

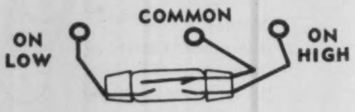


WEIGHT: 1¾ lbs.

FOR MEDIUMS NOT INJURIOUS TO STEEL OR SILVER SOLDER

CIRCUIT

SP-DT HERMETICALLY SEALED MERCURY SWITCH (4A. 115V., 2A. 230V.)



Provides any of following operations:

1. *Single Pole—Cut-in high (close on rise)*
2. *Single Pole—Cut-in low (open on rise)*
3. *Single Pole—Double Throw*

OPERATING RANGE

Adjustable Operating Range	Differential Fixed (Factory Set)	Maximum Surge Limits
1 to 20 psig	0.5 psig.	30 psig.

CONSTRUCTION

ADJUSTMENT: External
PRESSURE ELEMENT: Fairprene diaphragm
PRESSURE CONNECTION: ¼" I.P.S.
MOUNTING: Has two mounting ears (one on each side of control) or control may be pipe mounted by means of the ¼" I.P.S. bottom connection.
INTERNAL WIRING CONNECTIONS: 3 post terminal block.
CASE: NEMA 1—Heavy gauge steel, cadmium plated. Steel cover (with glass front) finished in charcoal-gray.

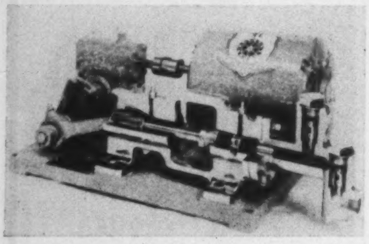
WRITE FOR BULLETIN 02

THE MERCOID CORPORATION
4201 Belmont Ave., Chicago 41, Ill.

Circle 691 on Page 17

designed into new machinery for an automatic production line. **Hilliard Corp.,** W. 4th St., Elmira, N. Y.

Circle 467 on Page 17

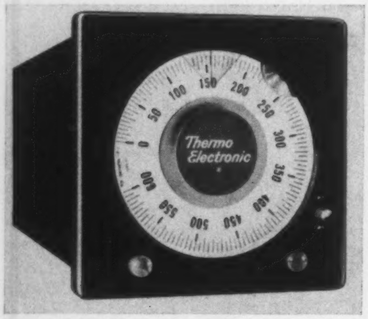


Proportioning Pump

Item 468

Reciprocating plunger pump can feed as little as 1.5 gph or as much as 108 gph of corrosive or noncorrosive liquids into chemical processes, food processes, or water treatment systems. The tanks in the pumps range from 50 to 250 gallons capacity. Accuracy is maintained through double suction and double discharge ball checks and seats. A special stroke control mechanism permits automatic or manual adjustment of the stroke from zero to full stroke while the pump is in operation. **Walter H. Eagan Co. Inc.,** 2336 Fairmount Ave., Philadelphia 30, Pa.

Circle 468 on Page 17

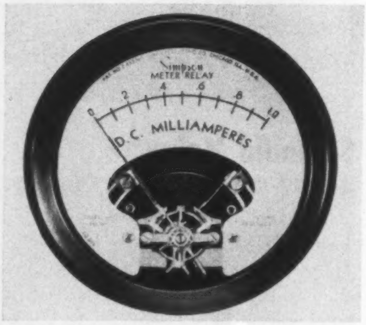


Signaling Controller

Item 469

Unit is suitable for use with any transducer generating a dc signal, such as thermocouples, tachometer generators, or load cells. Corrective action occurs almost simultaneously with detection of any input signal deviation. Controller will react to a change of 1 mu v; calibration is said to be within ±0.25 per cent of full scale span or 5 mu v. Ranges are available from 1 to 100 mu v. Feature of the unit is a high-gain control amplifier which combines stability with sensitivity and provides a favorable ratio of signal amplification to component electrical noise suppression. Amplifier stability is ±1 mu v; power gain is 135 db. Red and green signal lights on the instrument door indicate process conditions. A safety feature is the built-in control action which causes the control relay to shut off process heat immediately when failure of any system component occurs. **Thermo Electric Co. Inc.,** Saddle Brook, N. J.

Circle 469 on Page 17



Meter Relay

Item 470

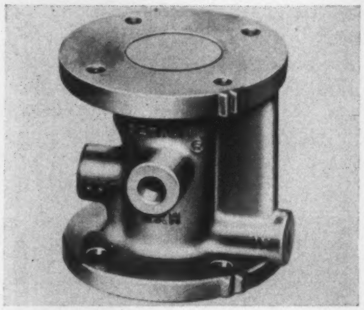
Indicating type relay is suitable for alarm systems, automatic sorting devices, automatic overload protection, low level switching, and automatic gaging. The controlling source can be either ac or dc. Available dc meter relay types include microammeters, milliammeters, and ammeters to 10 amp self-contained. The ac meter relay types are 500 mv to 500 v (rectifier type only); current ranges are from 100 microamperes to 20 ma. Unit has a dust-tight and splashproof front and back and can be supplied as a water tight device. **Simpson Electric Co.,** 5200 W. Kinzie St., Chicago 44, Ill.

Circle 470 on Page 17

Valve Delay Adaptor

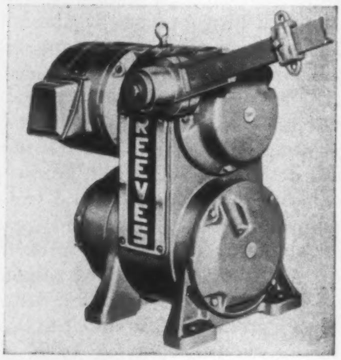
Item 471

Device extends the time delay of standard sequence heads by making available accurate time delays of up to one minute. It is adaptable with any TD head and any body in the company Skyline series.



The adaptor is constructed with an alternate internal or external pilot supply. Individual pressure can go directly to each of three working components or pressure can be supplied in any combination of hookups. **Ross Operating Valve Co.,** 120 E. Golden Gate, Detroit 3, Mich.

Circle 471 on Page 17

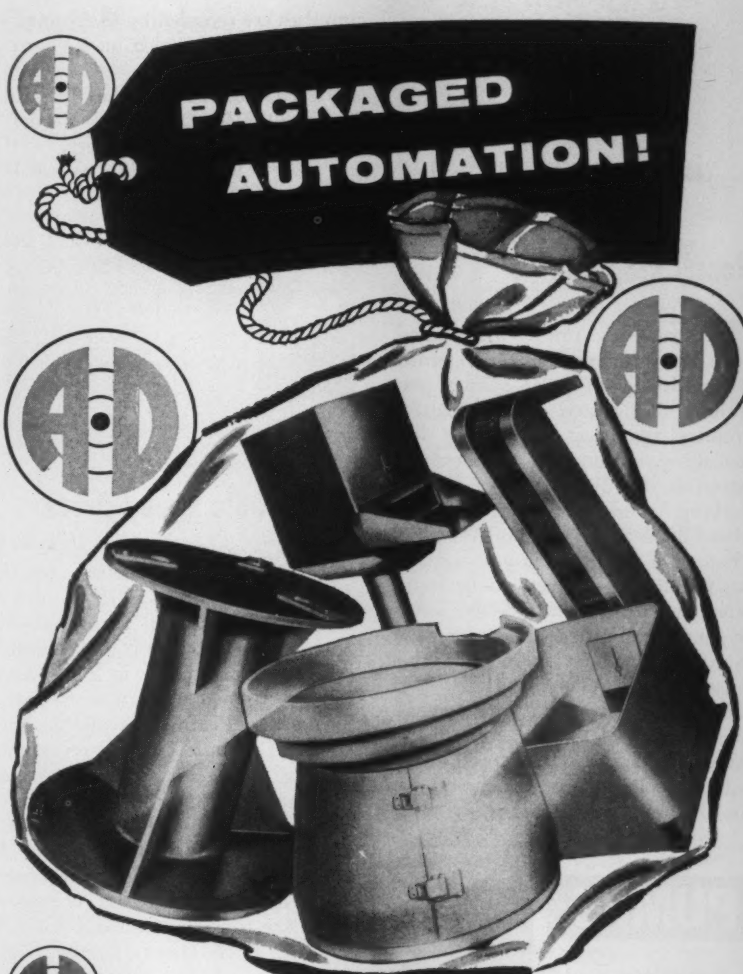


Drive Control

Item 472

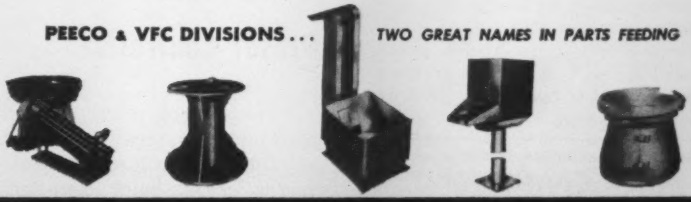
Designed for use on company's Vari-Speed Motodrives from 1/4 through 10 hp, mechanical device changes speed settings over ranges from 2:1 to 10:1, depending on the style and horsepower of the unit. An extended control lever replaces the usual handwheel and accurately changes drive output speeds from low to high with slight mechanical pressure and short travel. Lever can be positioned by any mechanical linkage. A built-in safety device protects the Motodrive from excessive force. **Reeves Pulley Co., Div., Reliance Electric & Engineering Co.,** 1225 Seventh St., Columbus, Ind.

Circle 472 on Page 17


PACKAGED AUTOMATION!

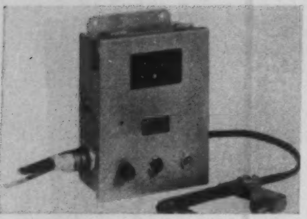
Achieve efficient, automatic production, and produce more all along the line, by integrating equipment designed and built by AUTOMATION for automation.
For example, vibratory parts feeders perform more efficiently on an engineered base permitting maximum power transmission. Either the side delivery or the elevating conveyor supply hoppers (with automatic paddle type relay switch to regulate delivery) hold large quantities of parts and are real labor savers. These are just a few advantages that make automation work and pay for itself.
You can depend on the proven talents at AUTOMATION DEVICES, INC.—enlist their help. Write today for the informative bulletin on "Packaged Automation."

PEECO & VFC DIVISIONS . . . ***TWO GREAT NAMES IN PARTS FEEDING***



AUTOMATION DEVICES INC.
ERIE, PENNSYLVANIA

Circle 692 on Page 17



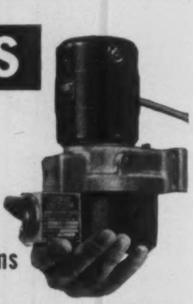
Electronic Counter

Item 473

Transistorized unit with photoelectric sensing system can operate at speeds up to 3000 counts per minute. Equipped with printed circuitry, counter is suitable for packaging, bottling, food processing, materials handling, paper, metalworking, and plastic operations where there is a high count velocity, where the counter cannot contact the product or package to be indicated, where the object is too weak or small to mechanically actuate a counter, or where speed is to be sensed from a revolving disc.

Model D is available with a separate photohead, which contains a cadmium sulphide photocell that will sense light impulses caused by the breaking of a beam. Signal impulses are received by the counter, amplified and recorded on a counting indicator. Unit will operate on a 105 to 125 v circuit, or can be supplied for 220 v ac. **Veeder-Root Inc.**, Hartford 2, Conn.

Circle 473 on Page 17



PUMPS

that offer
a new
approach
to your
design problems

BUILT-IN DIRECTIONAL CONTROL

Miniaturized in everything but power, Oil-Dyne pumps provide new economy and efficiency on standard hydraulic applications . . . make hydraulic actuation possible on applications never before feasible.

Oil-Dyne pumps simplify your design problems by eliminating external directional control valving . . . integral valving permits changing the direction of cylinder travel by simply reversing the motor. Pressures to 3,000 lbs. (5,000 lb. peaks); available with or without pressure switches and/or relief valves. Write for illustrated catalog.

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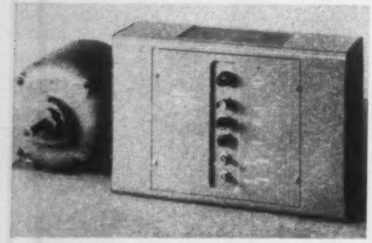
PUMPS • PRESSURE SWITCHES
CYLINDERS • VALVES • ACCESSORIES
OIL-DYNE INC.
2115E West Marquette Rd., Chicago 36, Ill.

Circle 693 on Page 17



Adjustable Speed Drive

Item 474

Adjustable speed drive uses a magnetic amplifier unit to drive thyratrons in a full wave circuit. Speed range of 100:1 and regulation percentages of 1 to 2 per cent can be attained without tachometer feedback. Features available include: Dynamic braking, reversing, jogging, remote control, torque limiting, and line voltage compensation. Drive is available in sizes ranging from 1/6 to 10 hp. A standard duty-line covers the range from 1/6 to ¾ hp and a heavy-duty line covers the range from 1/6 to 10 hp. **Cleveland Machine Controls Inc.**, 1155 Brookpark Rd., Cleveland 9, Ohio.

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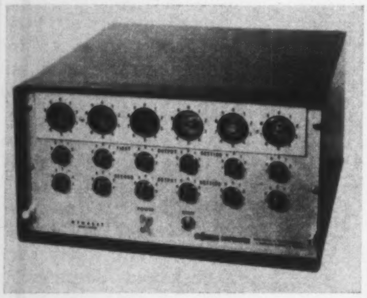
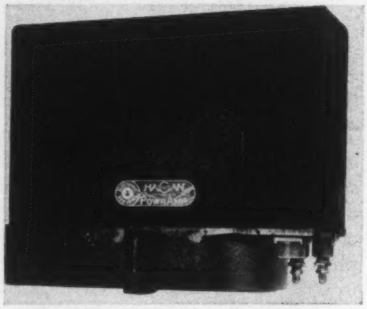


Preset Controller

Item 475

Transistorized preset controller is applicable for measuring and control functions such as automatic cutting-to-length, batch counting and sequencing, and automatic machine tool positioning. The unit, enclosed in a steel cabinet, has a slide-out chassis for plug-in servicing. It can operate directly from all types of sensing devices. The preset range is from zero to 180,000 counts per minute, with instantaneous reset. The numerical readout can be either glow counter tubes or in-line indicators. **Dynapar Corp.**, 5150 Church St., Skokie, Ill.

Circle 475 on Page 17



Low Pressure Transducer

Item 476

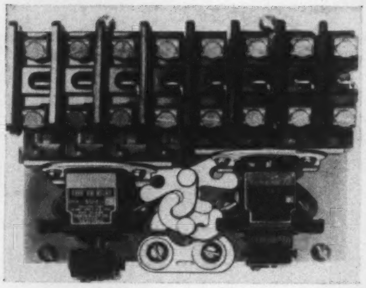
Line of pressure transducers features low drift qualities, is adaptable for electronic control and data readout systems. It is also used in single or multiple pressure readout systems with suitable digitizing and printing equipment. The transducers, designated Series A-2, are available in a scale range of 0-1.5 (minimum) and 0-3.8 (maximum), gage or absolute, at operating pressures up to 20 psig. Speed of response is 3 db at 40 cps; standard output ranges are 3 to 28 v and 0 to 25 v. Resolution sensitivity is 0.001 per cent of full scale and calibration accuracy is 0.1 per cent of full range; linearity is 0.05 per cent full scale. **Controls Div., Hagan Chemicals & Controls Inc.**, Route 60 at Campbell Run Road, P. O. Box 1346, Pittsburgh 30, Pa.

Circle 476 on Page 17

Relay Interlock

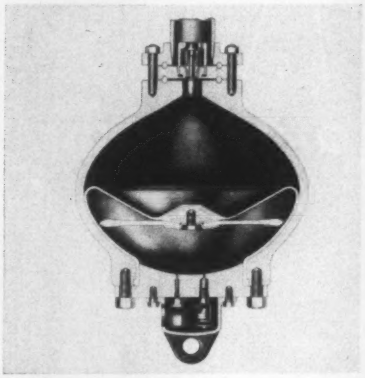
Item 477

Mechanical safety device is adaptable to company's Type PM and PMA 10-amp control relays. It is designed to be installed on two adjacently-mounted relays to prevent one relay from closing if the other is closed. The same mounting screws and holes used on the mounting plates of the relays can be used for the interlock. No additional



space is required, other than that available between the magnets of two mounted modular units. Precise alignment between the two relays involved is not required. **Clark Controller Co.**, 1146 E. 152nd St., Cleveland 10, Ohio.

Circle 477 on Page 17



Surge Absorber

Item 478

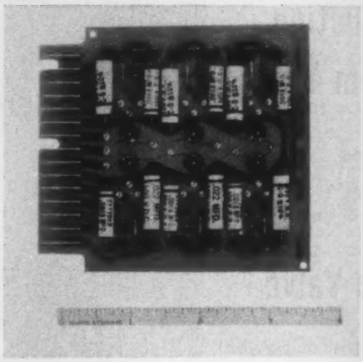
Unit is adaptable to any fluid-handling system for the control of line surges and pulsations due to the action of reciprocating pumps or the quick closing of valves. Absorber consists of a thick-walled surge chamber where a nonwrinkling diaphragm floats on the surface of fluid which enters from the line. Above the diaphragm, the chamber is precharged with gas to provide the pressure which forces the diaphragm downward to effect displacement of the fluid through the outlet. In the illustration, the absorber is equipped with a by-pass check valve which is installed at the inlet, providing an unobstructed opening to the surge chamber to absorb surge, and a restricted opening for controlled release of excess fluid to prevent backsurge. **Hydril Co.**, 714 W. Olympic Blvd., Los Angeles 15, Calif.

Circle 478 on Page 17

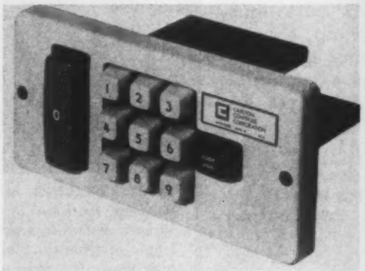
Circuit Module

Item 479

Magnetic module can be incorporated in digital systems such as computers, automatic control systems, test equipment, switching circuitry and shift registers. The digital unit reduces the number of active circuit elements and permits the operation of as many as fifty core stages from one drive transistor. Both core and solid state core driver modules are available. **Packard Bell Computer Corp.**, 1905 S. Armacost Ave., Los Angeles 25, Calif.



Circle 479 on Page 17



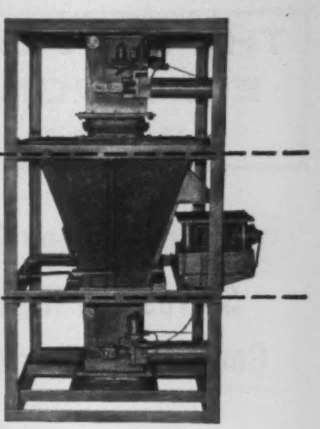
Pushbutton Station

Item 480

Numerical pushbutton station is adaptable for manual data input functions. Any combination of two, form A, B, or C contacts per station can be furnished. Momentary contact buttons are spaced on $\frac{7}{8}$-inch centers to reduce the possibility of accidental operation of more than one button at a time. Contacts for Model 3030 are rated 3 amp, 110 v, noninductive. **Carlton Controls Corp.**, 15 Sagamore Rd., Worcester 5, Mass.

Circle 480 on Page 17

THE W-C HOPPER SCALE



standardized components adapt it to a full range of material handling methods, control instrumentation

Take a good look at this hopper scale. It has many practical features for almost any weighing application.

Take the upper and lower frames. They are designed to accommodate many standardized feed and discharge components: sliding gates, vibratory feeders, screw feeders and others. These units are pre-engineered; their performance has been fully proven in use. Costs are, therefore, correspondingly lower. Satisfactory operation is confirmed in advance.

Now look at the middle or hopper frame. Note the flexure mountings. They give stability to the unit and deliver a single component of force to the weight transmitter regardless of load distribution. The transmitter, itself, may be either electric or pneumatic; the signal can be used for weight indication, recording, automatic batching.

Write for Catalog 12. Clear text, lots of pictures.

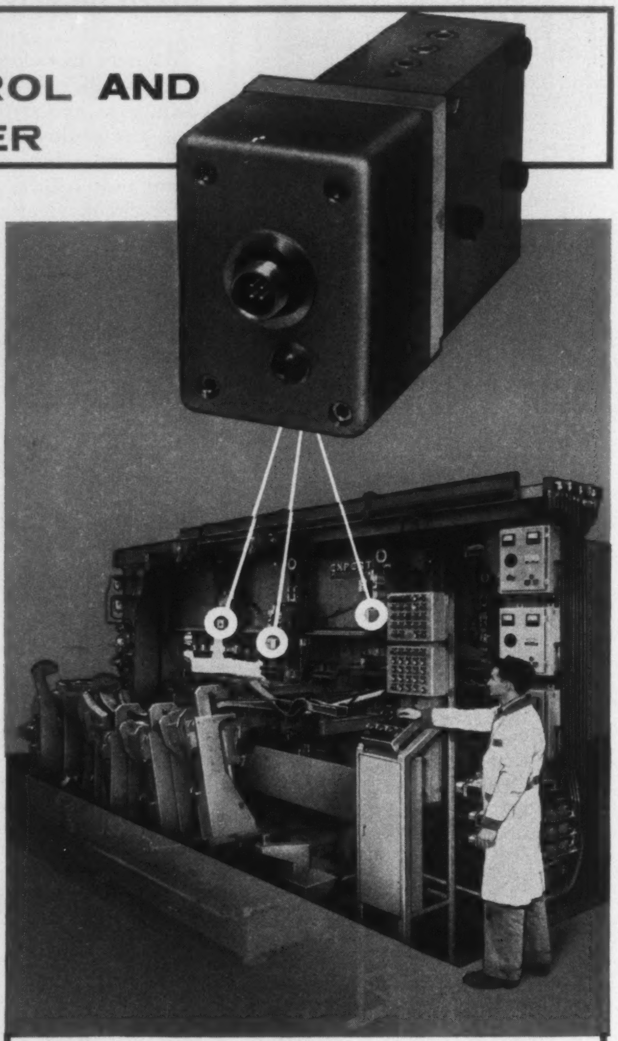
W-C

S.A. 1659

WEIGHING and Control COMPONENTS, Inc.
206-C Lincoln Ave., Hatboro, Pa.

Circle 694 on Page 17

THE LINK BETWEEN ELECTRONIC CONTROL AND HYDRAULIC POWER



Expert Welding Machine Co. Solves the High Production Contour Welding Problem With

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Electro-Hydraulic Servo Valve

The versatility of electro-hydraulic control of power has solved one of industry's toughest problems—automatic welding of complex and contoured automotive frame members.

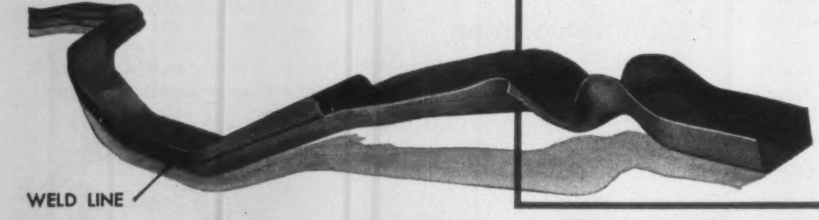
An electronic probe follows the weld line on the work and records any deviation from the path prescribed by a master cam. Any deviation from the governing cam contour creates an error signal which is amplified and fed to the servo valve. The servo valve converts these electrical signals into precise hydraulic flow to a cylinder which accurately positions the welding head allowing for variations in manufacturing operations . . . trimming, etc.

This application is only one of many in which Vickers Servo Valve has demonstrated exceptional performance under the exacting conditions of industrial production requirements.

Valve operation is simple. Reliability is assured—there are only four moving parts.

Investigate the production advantages offered by electro-hydraulics. **Write for Vickers Engineering Bulletin 58-74.**

EXPERT WELDING MACHINE COMPANY developed this automated welding machine that incorporates a magnetic-tape-tracer system. Vickers electro-hydraulic servo valve provides the link between electronic programming and hydraulic power. Vickers Pumps and Controls also used. The machine joins metal parts having untrimmed, out-of-tolerance, straight and/or contoured weld line edges.



Two U-shape channels are welded to form the box configuration in this complex automotive frame side member. Production is approximately 100 pcs/hr.

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8259

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Circle 695 on Page 17

catalogs and literature

Latest automation information. For copies use card on page 17.

Eyelet Machines

United Shoe Machinery Corp., Eyelet Dept., 140 Federal St., Boston 7, Mass. —48 page catalog—Eyelets and eyeleting machines, which are applicable in the metalworking, rubber, plastics, electrical, and packaging industry, are described. Dimensions, specifications, and line drawings are given on the different styles of eyeleting machines. Data are included on several classifications of eyelets—the eyelets are described and classified by type and by using industries. A table lists eyelets in order of ascending barrel diameters.

Circle 482 on Page 17

Permanent Plate Magnets

Stearns Magnetic Products, 635 S. 28th St., Milwaukee 46, Wis.—8 page bulletin—Permanent plate magnets for positive tramp iron removal are outlined in Bulletin 1074. Data are given on how to select magnets for existing chutes, ducts, conveyors, or other material handling equipment. Tables list recommended magnet size according to conveyor size, speed of material flow, size or mesh of material.

Circle 483 on Page 17

Pressure Switches

Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.—36 page catalog—Data are contained in Bulletin 9-PS on line of pressure switches. Types of units described include: Diaphragm, bourdon tube, and piston. A glossary of terms, functional schematic symbols, and notes on selecting the proper switch are given. Spare parts table, electrical rating tables, adjustment instructions, and an ordering chart are also included.

Circle 484 on Page 17

Synchro & Rotary Components

Clifton Precision Products Co. Inc., 9014 W. Chester Pike, Upper Darby, Pa.—24 page catalog—Data are contained in Bulletin SC-3-59-10M on line of precision computing resolvers, linear transformers, and synchros in sizes from 8 through 22. Other units described are: Motor generators in sizes 8 through 11, gearhead motors, and size 8 dc motors. Electrical and mechanical characteristics are given and performance charts show speed torque curves.

Circle 485 on Page 17

Mass Spectrometer

Analytical & Control Instrument Div., Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.—16 page booklet—Mass spectrometer, an instrument applicable for refinery stream analyses, chemical reaction processes, metallurgy reduction, and absorption techniques, is described in Bulletin 1800E. Principle of operation of the spectrometer is explained, aided by a diagram showing the working principles. The analysis procedure is discussed and notes are included on company's installation and maintenance service.

Circle 486 on Page 17

Tape Control Positioning

Machine Tool Div., Jones & Lamson Machine Co., Springfield, Vt.—10 page bulletin—Tape control positioning described in Bulletin LO-5902 is applicable to operations such as drilling, spot-welding, or stamping. The tape preparation and electrical control system is explained, as is the servo and position measuring system. Also included are application photos.

Circle 487 on Page 17

Bending Machines

Pines Engineering Co. Inc., Aurora, Ill. —24 page catalog—Data are contained in Catalog 356 on bending machines for tubing, pipes, extrusions, and rolled sections. Basic bending principles and the tooling required are discussed. Features of the different models are noted with close-up photos showing the various machines in operation. Accessories for some of the machines are also described.

Circle 488 on Page 17

Magnetic Tape Instrumentation

Minneapolis-Honeywell Regulator Co., 10721 Hanna St., Beltsville, Md.—24 page catalog—Multichannel magnetic tape systems for laboratories, test cells, and telemetering recording are described in Catalog DC-3171. Typical systems and basic factors to consider in selecting a system are discussed. Component specifications are given for magnetic heads, transports, and power supplies; and performance specifications are noted for frequency modulation, pulse duration modulation, and direct and digital tracks.

Circle 489 on Page 17

Slider-Board Belt Conveyors

Sprout, Waldron & Co., Inc., 130 Logan St., Muncy, Pa.—4 page pamphlet—Slider-board belt conveyors, which are capable of handling large quantities of fragile bulk materials, are described in Bulletin 175-B. Construction, installation, and operational details are given. Close-up photos display the drive mechanism and the ease of accessibility for inspection and cleaning. Engineering drawings show specifications and capacity ratings.

Circle 490 on Page 17

Crane Control Equipment

Harnischfeger Corp., 4400 W. National Ave., Milwaukee 46, Wis.—32 page catalog—Electrical and electronic equipment for overhead cranes is described in Bulletin C5-2. Speed-regulating characteristics of the control are noted, as are speed-load curves for all crane motions. Data are also included on a precision weighing device built into the crane load-block which weighs and records loads on the hook.

Circle 491 on Page 17

Process Variables Measurement

Norwood Controls Unit, Detroit Controls Div., American-Standard, 934 Washington St., Norwood, Mass.—10 data sheets —A nonelectronic signal generator system is described in Bulletin B258 (formed from series of data sheets). The system is capable of measuring, indicating, recording, controlling, or telemetering numerous types of process variables. Data are given on the different units which comprise the system; such as signal transmitter (transducer), power unit (magnetic servo amplifier), nullbalance indicating receiver, signal transmitter, and strip-chart recorder. Outline drawings and wiring drawings are included.

Circle 492 on Page 17

AIR-HYDRAULICS

"EXPLODED AIR"

IMPACT HAMMER

MORE STROKES / CU. FT. AIR / MINUTE

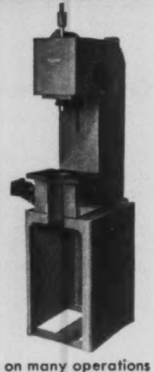
NO FOOLIN', when operated at 100 psi line pressure the Model Z-2, 12,000 lb. hammer illustrated will make 50 strokes per cubic foot of air. That's at a rate of 60 per minute on manual control or upwards of 120 on automatic. The Model Z-6, 40,000 lb. capacity hammer will punch out 15 strokes per cubic foot at the same rates.

EASILY ADJUSTABLE to any pressure within capacity, impact is then constant at any point in the stroke. Variations in stock thickness or improper positioning are handled without damage to work, dies or hammer.

FOR THOSE AWKWARD JOBS, from forming to forging, the head of the Z-2 may be purchased separately and mounted at any angle, even upside down.

AIR-HYDRAULICS

EQUAL PRESSURE THROUGHOUT STROKE



ELIMINATES TROUBLES—caused by material thickness variations, improper seating and other factors. Model C-250 Air-Hydraulic Press shown delivers pressures up to 2½ tons, Model C-300 pressures to 5½ tons on standard air line pressures. May be purchased with stand or for bench installation and equipped for manual control, foot control or fully automatic operation. Speeds up to 3,000 strokes per hour on automatic. Replaces foot or arbor presses on many operations in materials ranging from metals to ceramics.

ADJUSTABLE—Ram pressures may be varied from a feather touch for the lightest jobs to maximum for the heavy ones • Snail speeds if desired • Stroke length adjustment has a 2" range • Effortless quiet operation makes this press ideal for women operators.

OUR NEW CATALOG IS READY NOW.
Write for yours today.

AIR-HYDRAULICS

299 HUPP AVE.
JACKSON, MICHIGAN

Circle 696 on Page 17

Sprockets & Chain Drives

Cullman Wheel Co., 1344 Altgeld St., Chicago 14, Ill.—88 page catalog— Specifications and dimensions on more than 1300 sprockets and numerous types of roller chains are given in Catalog 60. Some of the type of chains described include: Double pitch, heavy duty, and cable chains. Details are given on chain drive selection, installation, and chain length calculation (with chain length conversion tables). Other tables which are included are: Horsepower tables, speed ratio tables, sprocket specifications and diameters.

Circle 493 on Page 17

Basic Circuits

*Automatic Electric Co., Northlake, Ill.—32 page catalog—*Basic circuits are given which can be the "building blocks" of automatic switching systems. Sketches show relay coil symbols and relay coil terminal connections. Other sketches show slow-operating and slow-releasing circuits, relay locking circuits, ac rectifier circuits, and rotary switch circuits.

Circle 494 on Page 17

Automatic Assembly Machine

*Sperry Products Inc., Danbury, Conn.—12 page booklet—*A basic automatic assembly machine with interchangeable assembly tools is the subject of Bulletin 41-110. By changing the tooling, the unit can perform types of operations such as inserting, crimping, staking, spinning, screw driving, riveting, inspection, and welding. Operation of the 16-station machine is explained, with close-up photos showing how the tooling can be interchanged.

Circle 495 on Page 17

Materials Feeder Control

Detecto Scales Inc., 540 Park Ave., Brooklyn 5, N. Y.—2 page pamphlet— Data are contained in Bulletin Y100 on magnetic mercury switch cutoff accessories which control materials feeder elements such as gates, conveyors, screws, and valves for the weighing of solids and liquids. Applications and operation of the different styles are explained.

Circle 496 on Page 17

Punched Data Equipment

*Remington Rand, Div., Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.—8 page bulletin—*Advantages of common language tape and edge-punched card machines are discussed in Bulletin RT 8986. The system, described as "chain reaction" automation, produces automatic machine-to-machine processing of paper work from the initial document to the final data. Bulletin describes a punched-tape typewriter and a punch/read tape unit that can be synchronized with a typewriter. The system can handle 5, 6, 7, or 8 channel tapes or edge-punched cards.

Circle 497 on Page 17

Induced Draft Fans

*Lehigh Fan & Blower Div., Fuller Co., Catasauqua, Pa.—16 page booklet—*Line of induced draft fans for mechanically and hand fired boilers is described in Bulletin L-3. Photos show the features of the fans. Dimensional drawings showing the different views of the fans are included; as are schematic diagrams of installations.

Circle 498 on Page 17

Direct Writing Recorders

*Brush Instruments, Div., Clevite Corp., 37th & Perkins, Cleveland 14, Ohio—16 page booklet—*Bulletin 1100, entitled "New Concepts In Recording", discusses various methods of recording. Principle of operation is explained and circumstances under which direct writing recording systems provide maximum benefit are identified and defined. Data are given on oscillographs, special-purpose amplifiers, and system confrigurations.

Circle 499 on Page 17

Electrical Connectors

*Electrical Products Div., Joy Mfg. Co., 1241 Macklind Ave., St. Louis 10, Mo.—12 page booklet—*Data are contained in Bulletin B73 on line of electrical connectors. Styles shown include: Oval push-pull, round push-pull, round push-latch, quiklock, straight pin bigun, round push-lock, and change-out. Applications, contact arrangements, types of receptacle mounts, and accessories for the different units are described.

Circle 500 on Page 17

Meter Accounting System

B-I-F Industries Inc., 345 Harris Ave., Providence 1, R. I.— 4 page pamphlet— A meter accounting system, suitable for summating multiple meter flows in the pipeline industry is discussed in Bulletin SM-3280. Methods of meter accounting using "building block" construction is described, with a drawing showing the typical arrangement of the unit. Illustrations display the three styles of meter panels and various installations.

Circle 501 on Page 17

Wire Straightening & Cutting

*Vaughn Machinery Co., Cuyahoga Falls, Ohio—8 page bulletin—*Wire straightening and cutting machinery described in Bullein 751 is designed to deliver uniform lengths of straight, precision-cut wire at variable speeds up to 300 fpm. Data are given on features of the machine such as the electric variable speed drive, adjustable center straightener arbor, and synchronized flying shear cut-off. Illustrations show full length views and closeups of various parts.

Circle 502 on Page 17

Word Indicator Lights

*Master Specialties Co., 956 E. 108th St., Los Angeles 59, Calif.—16 page booklet—*Unit described, designated Roto-Tellite, is a word indicator light used to indicate various functions or faults. The legend area, lettering, and type of lenses available are explained. Schematic diagrams help explain the operation of the diode dimming circuit and the dc diode test circuit. Numerous sketches of circuits with positive input and negative input are also included.

Circle 503 on Page 17

Flaring Machine

Parker Fittings & Hose Div., Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio—16 page booklet—A pneumatically operated machine for forming a double lap flare on the end of ferrous and nonferrous tubing is the subject of Catalog 1145-A16. The use and maintenance of the machine is discussed. A schematic plumbing diagram is given along with a chart listing possible malfunctions and their cures. Other charts list parts breakdown.

Circle 504 on Page 17

Instrumentation Recorder

Precision Instrument Co., 1011 Commercial St., San Carlos, Calif.—8 page bulletin—Model PS-200, a 7 channel, magnetic tape recorder/reproducer which weighs 65 lb, and requires only 250 w of power is the subject of Bulletin 55. Features of the unit, such as transistorized electronics and a stacked reel tape magagine, are described. Mechanical and electrical specifications are listed.

Circle 505 on Page 17

Electric Process Heaters

Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.—64 page catalog—Data are given in Catalog 60 on over 15,000 types of heaters. Some of the types of heaters include immersion heaters, circulation heaters, and air heaters. Sketches show the various arrangements possible for different applications. Technical data are given for calculating heat requirements.

Circle 506 on Page 17

Multipurpose Dumpers

Essex Conveyors Inc., 165 Franklin Ave., Nutley 10, N. J.—8 page bulletin—Data are given on line of various sizes of material dumpers which are capable of handling drums, bulk material, or bags. The dumpers can lift, up-end, dump, and return the skip automatically. Application photos and dimensional drawings are included.

Circle 507 on Page 17

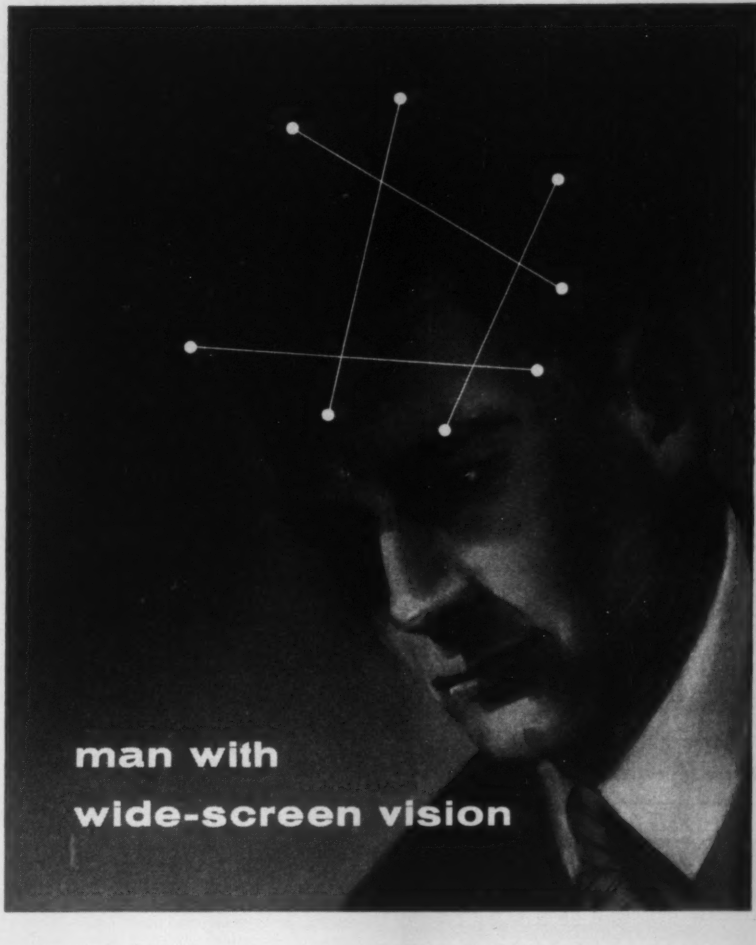
Snap-Acting Switches

Unimax Switch Div., W. L. Maxson Corp., Ives Rd., Wallingford, Conn.—28 page catalog—Precision, snap-acting switches for control and indicating circuits are described in Catalog 359. Dimension drawings, force and movement specifications, and electrical ratings are given. Data on bases, terminals, circuit arrangements, and definitions of switch terms are also included.

Circle 508 on Page 17

Phototubes

CBS-Hytron, Parker St., Newburyport, Mass.—6 page pamphlet—Bulletin PA-227, entitled "Phototubes and How to Use Them" explains photoemission and spectrum response. It also describes the phenomenon of gas amplification, gives precautions concerning environment, and discusses the phototube rating system. Sketches show typical circuits using high-



"The Man from Logan" has had years of vital personal experience in solving conveyor problems for busy plants like yours. So when he turns down the house lights, so to speak, and gives your problem the first screening, he sees it real and sees it whole.

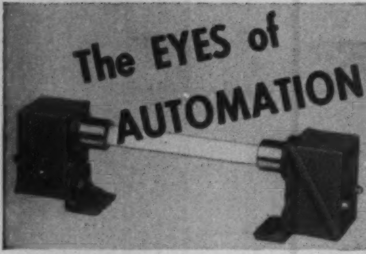
This wide-screen vision is your ultimate assurance of the one best custom engineered conveyor system at the lowest feasible cost. Behind it, of course, is a solid academic engineering background and the special training and equipment to focus two generations of Logan experience directly on your job. Through "The Man from Logan" you benefit from a progressive research and development staff and an eminently qualified home-office engineering force, as well.

He sees your system through from design and specifications to smooth operation. The man and the company—there is no better source for your conveyor. Write or phone for a visit from "The Man from Logan."

Logan Conveyors

LOGAN CO., 218 CABEL ST., LOUISVILLE 6, KY.

Circle 697 on Page 17



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Circle 509 on Page 17

Printed Circuit Connectors

Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.—24 page catalog—Printed circuit connectors which accommodate 1/16, 3/32, or ⅛-inch printed circuit cards are described in Bulletin 600. Sketches show a cross-section view of the contact with inserted printed circuit board and the different mounting arrangements possible. The units are manufactured by Continental Connector Corp.

Circle 510 on Page 17

Data-Gathering System

Stromberg Time Corp., Subsidiary, General Time Corp., Thomaston, Conn.—8 page bulletin—Subject of Bulletin DS-2 (designated Transacter System) is an automatic all-purpose data-gathering system which serves as a communication link between source of original entry at multiple, widely scattered transaction points and a central data-processing office. Principle of operation is explained, as is the flexibility of programming. Sketches show the different applications.

Circle 511 on Page 17

Feeders & Conveyors

Jeffrey Mfg. Co., Columbus 16, Ohio—96 page catalog—Data are contained in Catalog 930 on line of electric vibrating feeders and conveyors which can handle a variety of materials ranging from wood flour and peat to abrasive grains and glass cullet. Principles of design and operation are explained and the different types of electrical controls are described. Installation methods are discussed with numerous application photos included. Data are also given on a constant weight feeder, dryers and coolers, vibrating screens, magnetic separators, and vibrating barrel packers.

Circle 512 on Page 17

Speed Reducers

Industrial Products Div., Western Gear Corp., P. O. Box 126, Belmont, Calif.—15 page booklet—Data are contained in Bulletin 5908 on line of vertical-helical speed reducers. Mechanical, thermal, and thrust load ratings are explained and outline dimensions for both double and triple reduction are given. Also included are notes on a typical vertical-helical dry well lubrication system.

Circle 513 on Page 17

Recorders & Controllers

General Electric Co., Schenectady 5, N. Y.—12 page booklet—Continuous, self-standardizing strip-chart recorders and recording controllers for measurement of electrical and process variables are outlined in Bulletin GEA-6887. Schematic drawings show typical control systems and and typical switching action. Optional features available from the Instrument Dept. are also noted.

Circle 514 on Page 17

Mercury Displacement Relays

Adams & Westlake Co., Elkhart, Ind. —16 page booklet—Mercury displacement relays are described which are suitable for use in timing, load, and control circuits. Time delay characteristics, contact arrangements, and contact ratings for the different units are listed. Sketches show the mounting arrangements possible for mercury plunger type relays.

Circle 515 on Page 17

Centralized Lubrication

Industrial Div., Lincoln Engineering Co., 4010 Goodfellow Blvd., St. Louis 20, Mo.—16 page booklet—Centralized lubrication and its advantages over other methods of lubrication are discussed in booklet entitled, "A Report to Management." Data on basic centralized systems are given and case histories of uses in major industries are described. Operating characteristics of the lubricant injectors are explained and five practical steps for converting to automatic lubrication are noted.

Circle 516 on Page 17

Pipeline Control

Cooper-Bessemer Corp., Mount Vernon, Ohio—14 page booklet—Bulletin 87 covers automatic controls for engines and compressors. The equipment described is capable of automatically starting, loading, capacity controlling, regulating, and shutting down pipeline compressors. A schematic diagram shows the placement of parts in a unit.

Circle 517 on Page 17

Digital Instruments

Computer Measurements Co., 5528 Vineland Ave., North Hollywood, Calif.—12 page booklet—Data are contained in Bulletin 10M on line of digital instruments. Included in the line are: Transistorized frequency-period meters, digital voltmeters, digital printers, universal counter-timers, time interval meters, inline-inplane readouts, preset counter controllers, and decade counting units. Features and specifications are noted.

Circle 518 on Page 17

High Vacuum Pumps

Vacuum Equipment Div., F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.—4 page pamphlet—High vacuum pumps in 2 and 3 cfm capacities are outlined in Bulletin 990. The pumps are suitable for applications where a blankoff pressure of 0.1 micron is needed. Features, specifications, and pumping speed curves are given.

Circle 519 on Page 17

Transistors & Rectifiers

Semiconductor Products, Red Bank Div., Bendix Aviation Corp., Westwood Ave., Long Branch, N. J.—23 data sheets—Line of germanium transistors and silicon rectifiers are described. Operating characteristics are noted and transistor replacement charts and maximum rating charts are included. Prices and ordering instructions are also given.

Circle 520 on Page 17

Magnetic Recorder/Reproducer

Mincom Div., Minnesota Mining & Mfg. Co., 2049 S. Barrington Ave., Los Angeles 25, Calif.—4 page pamphlet—Model CV-100, a 7-track video band magnetic recorder/reproducer is the subject of pamphlet. Operational characteristics and design features are described. Photos are included which show oscilloscope traces and indicate quality or reproduction obtained with the equipment.

Circle 521 on Page 17

Servomechanism Components

PIC Design Corp., 477 Atlantic Ave., East Rockaway, L. I., N. Y.—20 page booklet—Servomechanism gear train packages are outlined. Details are given on the use of instrument plates and cluster gears in providing precision assemblies. Sequence data are given, along with dimensional drawings. Basic design concept and standards are discussed.

Circle 522 on Page 17

Instrument & Control Panels

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio—16 page booklet—Details of construction, dimensions, weights, instrument mounting, and accessories for six styles of instrument and control panels are given in Bulletin G71-7. Standard procedures for tubing and wiring are discussed, aided by schematic diagrams.

Circle 523 on Page 17

Electronic Computer

Data Processing Div., Royal McBee Corp., Port Chester, N. Y.—6 page bulletin—Model LGP-30, an electronic computer is the subject of report. It is explained how the computer can determine the load flow in electrical networks of up to 100 busses and 270 lines. The procedure for solving the problem is described, aided by a typical load flow chart.

Circle 524 on Page 17

Conveying Control Systems

Trans-Weigh Co., King of Prussia, Pa. —8 page bulletin—Line of equipment used for automatic process weighing and control and inventory weighing is described in Bulletin 2M. The system, designated Belt-Meter, controls the flow of belt-conveyed solids in industries such as metal producing, mining, power, paper, cement, and chemical processing. Data are given on the basic components in the system, weighing feeders, and the continuous integrator used for high precision inventory weighing. Schematic diagrams show typical applications.

Circle 525 on Page 17

Machine Programming

Potter & Johnston Co., West Hartford, Conn.—12 page booklet—An automatic tape control system, which can be used with turret lathes and other machine tools is described in Bulletin 176. The step-by-step procedure in preparing to produce a part under tape control is explained, aided by reference charts and sketches of operation sheets.

Circle 526 on Page 17

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AUTOMATION abstracts

INDUSTRIAL ROLE OF MANUFACTURING ENGINEERING

By R. H. McCARTHY
Plant Design & Construction Div.
Western Electric Co. Inc.
New York, N. Y.

MANUFACTURING ENGINEERING calls for a wide diversity of talents applied neither to the use of a product nor to the supervision of people who make it, but to problems of how to make it. The engineers who work on manufacturing problems must understand the product, its use, and the need to hold down costs. They must know processes and how to design the tools, machines, and factories that make the processes possible. They must cement product design to manufacturing processes with wise application of economics and human skills. The problems are in the field of engineering and can be solved by engineering methods.

Actually, the problems of product design are inseparable from those of manufacturing processes, and the problems of processes cannot be completely divorced from those of personnel management. Hence, a product design organization must keep an eye on and identify itself with production, and manufacturing engineering must work on product design. Overlapping also occurs between manufacturing engineering and shop supervision.

In spite of such overlapping, it is possible and necessary in good practice to define the engineering functions and responsibilities of each of these three groups. This can be done in relation to the steps of an industrial project, TABLE 1. Specifically, responsibility for the design of a product should be the designer's. As a corollary, changes in product design, whether they originate in or out of the design organization, should be cleared by it. Similarly, since manufacturing engineers are responsible for manufacturing methods, changes in methods should clear through them. In the same way, instructions to workers should clear through shop supervision.

In fixing physical, electrical, chemical, and appearance dimensions, the experienced product designer knows he must consult with manufacturing engineers to insure that the design will fit, at reasonable costs, known processes or processes that can be developed. Often when analyzing the design, in order to make a preliminary cost estimate, the manufacturing engineer does and should suggest design changes. Also, the designer usually has to arrive at some compromise with the manufacturing engineer as to the number of attributes that can be dimensioned. This co-operation between designer and manufacturing engineer becomes increasingly important as the use of highly specialized production machines increases.

Manufacturing Engineer's Responsibility

The more clearly we define the responsibility of the product designer, the more clearly does the responsibility of the manufacturing engineer stand out. First, he must understand the design, then he must accept the design as being possible of manufacture. He must provide materials, facilities, and personnel that can make products which meet all requirements of the design. He must manufacture at lowest possible costs. He must ship only those products that meet design requirements. These prerequisites have a number of engineering aspects that can be readily identified, TABLE 2.

A number of criteria for effective organization should be applied to these manufacturing engineering responsibilities before assuming that they should be combined in one organization instead of several. First, does the group carrying out the work have common interests? Their common interests are the product, the long term value of plant provided, and the need for engineering treatment of the problems involved.

TABLE 1—Steps of an Industrial Project

1. Research
2. Development
3. Model construction
4. Model trial
5. Manufacturing review
6. Preliminary cost estimate
7. Design
8. Trial installation
9. Final design, specification, and issue of drawing
10. Manufacturing analysis
11. Inspection analysis
12. Material handling analysis
13. Facility analysis
14. Facility design
15. Final cost estimate
16. Facility procurement and installation
17. Tool-made sample review, approval
18. Job rating analysis
19. Wage incentive analysis
20. Quality assurance planning
21. Production programming
22. Piece parts production and test
23. Subassemblies production and test
24. Final assembly production and test
25. Inspection
26. Packing and shipping

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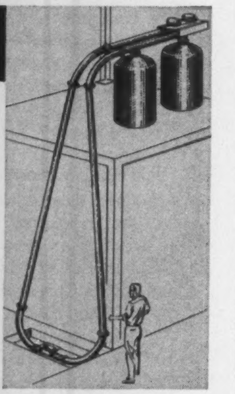

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Circle 704 on Page 17

Second, does this grouping save confusion, conserve effort? At the risk of oversimplification, the assumption is made that if the responsibilities of an organization can be simply stated in a way that clearly differentiates it from other organizations, elimination of confusion and duplication of effort will follow. The basic responsibilities for design liaison, prescription of manufacturng methods and processes, and provision of facilities seem reasonably free from misinterpretation and confusion.

Third, can the organization's effectiveness be measured? The direct measures are the ability of the group to find a way to make the product, the cost of the product when made in the way prescribed, and the facilities furnished. Success in developing new processes that stimulate new and better designs of products may also be a guide to effectiveness.

Fourth, does a continuing need exist for the effectiveness of the organization? The need for an organization charged with the responsibilities outlined depends upon a continuing input of challenging new product designs and continuing expansion of available manufacturing techniques. It does not depend upon the job conception and personality of one or a few individuals.

Of course, these criteria distinguish manufacturing engineering only from other manufacturing organizations. They do not guarantee that a random arrangement of the internal organization of such a group will be effective.

From this background, the conclusion follows that the need for a profession of manufacturing engineers stems primarily from the separation of product design responsibilities from other responsibilities and from the demand for interchangeable, highly technical, and exactly controlled products. The need for the profession stems only incidentally from the desire for lower costs. For the former need it is indispensable; for the latter it is desirable.

Several possible groupings of the activities listed in TABLE 2 are apparent. The first four items center on the manufacturing engineer's interest in the product design. This involves understanding of its objectives, consultation with the product designer as to manufacturability and cost, and translation and subdivision of design requirements into shop language. Sometimes models must be built to assist the designer and to learn more about the design. Items 6, 7, 8, and 13 bear on how to make the product and the facilities required. The ninth activity emphasizes design of manufacturing facilities which may or may not be commonly found in industry. Items 7 and 14—development of new processes and methods, and cost reduction—require ingenuity, considerable initiative, and development ability.

Company Structure

Rather than speculate on the organization of theoretical groupings, an established manufacturing engineering organization—the Engineer of Manufacture organization in the Manufacturing Division of the Western Electric Co. Inc.—will be described. This organization includes two kinds of manufacturing engineering departments. One associates directly with a

TABLE 2—Responsibilities of a Manufacturing Engineering Organization

1. Assistance to designers in development of product
2. Preparation of preliminary cost estimates
3. Continuing liaison with product designers
4. Interpretation and transmission of product design information to all manufacturing activities
5. Control of purchased material specifications
6. Designation of processes and detailed steps by which product is to be made
7. Development of new processes and methods when required
8. Determination of kind and amount of facilities required
9. Design and provision of facilities required
10. Development and designation of inspection methods
11. Rating of job as to personnel skills required
12. Shop assistance in manufacturing difficulties
13. Final estimates of new products' costs
14. Continuing cost reduction by suggesting product design changes and by introducing better facilities, processes and combinations of human skills

particular shop department. The other gives routine or technical consulting service to the first.

Each shop department looks to its associated manufacturing department for all the manufacturing engineering services it requires. If the manufacturing engineering department does not originate the information, instruction, or facility upon which a specific need for service is based, it must get, approve, and deliver these items. The manufacturing engineer works with the Bell Telephone Laboratories product designer to insure that the product can be made consistently with high quality and at reasonable cost. He accepts or rejects the manufacturing aspects of the product design and becomes headquarters for manufacturing drawings and specifications.

The manufacturing engineer has to work with human effort in the shop to express his ideas. Amounts of skill, kinds of skill, and implementation of skill must be selected and applied. He plans the co-ordination of human effort with tools, machines, power, and factories. He lays out and records for the shop each step of production from piece part through assembly, test, and inspection. These records are the basis for assigning labor grades, setting wage incentives, and establishing costs. He specifies the kind of material to be used for each part according to the designer's requirements, or according to standard practice, and states the amount of material required per part. He decides what tools and machines are to be used and provides the number required. The steps of production at which inspection is to be made, and how the inspection is to be made, are specified by his department. He determines how much space is to be provided for the shop, and how it is to be arranged and equipped.

Manufacturing information flows constantly from the department. This information applies to changes of design, tools and machines, alternative material stocks, changed floor plans, inspection methods, increased or decreased quantities to be made, supplier and shop difficulties, better application or organization of operator skills, and hazard reduction.

Intermittently, large projects arise for which management looks to the manufacturing engineer and the technical staff for information and advice. Once a

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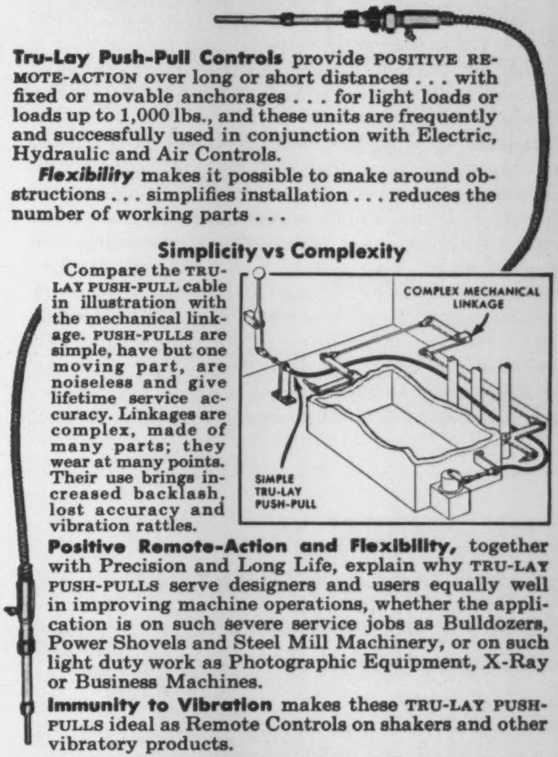

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Circle 705 on Page 17

large project is approved, management gives the manufacturing engineer great technical and economic leeway. If the project requires intensive investigation over a long period, it may be organized as a development project which shifts to routine treatment as processes become firmly established.

The soundness of large projects rests to a great degree upon the foundation built in the handling of small items. A major project requires skill with economic studies, experience in introducing new parts and assemblies, and good judgment as to the time required to introduce them. Practice with a variety of manufacturing methods leads to quick selection of suitable processes and accurate appraisal of their economies and resultant product quality. Experience with former projects yields orderly transitions from one product to another and freedom from unexpected delays in product schedules. Experience in bringing all the specialized skills of a large organization to bear upon a project, gives boldness and confidence in undertaking entirely new processes rather than patching up old methods.

Much of the success of the manufacturing engineer depends upon his ability to keep open avenues to the product designers, to a variety of manufacturing technologies, to his own related technical consultants, to the operating organizations, and to the accounting organization. His work is unsuccessful if he does not understand that manufacture of interchangeable, complex, and high quality products depends upon recorded, detailed instructions for each step in manufacture and that his control over these instructions greatly facilitates initiating changes that inevitably arise.

Depending upon their magnitude, the plans and decisions of manufacturing engineers are subject to approvals by higher levels of supervision. If the decisions involve radically new practices or far reaching changes, there will be numerous conferences with shop supervision to acquaint them with plans and to obtain the benefit of their experience.

Technical Service Departments

A single department of manufacturing engineers, varying in size from five to twenty people, cannot have experts in all the broad range of responsibilities required of the Manufacturing organization. Therefore, a number of other departments, of a service nature or of technical consultant caliber, exist to provide general services or to concentrate specialized technical services. These departments of specialists are obligated to keep the engineering groups assigned to shops informed of the best tools, machines, finishing methods, metal joining practices, and general factory services available, and to design them when needed.

To insure co-operation, all requisitions for manufacturing facilities, changes, and rearrangements must have two kinds of approvals, one for expenditure, the other for facilities design. Expenditure approvals come from the manufacturing engineering line organization. Design approvals are given by specialists such as tool designers, test set designers, standard machine procurement personnel, and factory engineers.

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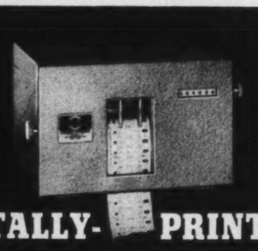

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Circle 707 on Page 17

A sharp line between shop engineering and technical consulting is undesirable. For this reason, both kinds of manufacturing engineering are brought together in each superintendent's organization. The resulting balance between the two functions is important to the well-being of the over-all manufacturing engineering organization.

Types of Personnel

A broadly based manufacturing engineering organization demands many kinds of people. In terms of conventional training, people having bachelor degrees in mechanical and electrical engineering are needed in the largest numbers—followed by chemical engineers, metallurgists, civil engineers, and technologists. The manufacturing engineers must thoroughly comprehend the product. They must be able to discuss all phases of it with the designer, helping him by design suggestions and manufacturing means to achieve a suitable product. Their responsibility gives wide range for mechanical design ability in providing intricate tools, machines, and handling equipment to implement plans of production. In the electrical field, test set engineers must design circuits for electrical and mechanical measurements such that the variability of test sets when operated continuously by unskilled personnel is only a small fraction of that permissible in the product. Some engineers are needed to design and modernize the water, compressed air, power, plumbing, ventilation, lighting, and other services that are critical to the operation of a large factory. A supporting force of clerks, draftsmen, model builders and laboratory technicians is needed to take many routine matters off the shoulders of the engineers.

One ability that is required of all shop engineers and some technical service engineers, is the ability to assemble reliable, comprehensive economic data and to prepare sound recommendations from them. All this must be done with realization of effects upon the design of the product and upon large numbers of individuals ranging from those who make the product to the customer.

From a paper entitled "Organization for Manufacturing Engineering" presented at the American Management Association Manufacturing Orientation Seminar (#402-94), Montreal, Canada, June 1959.

RADIOISOTOPES IN INDUSTRY

By PAUL KRUGER
Mgr., Dept. of Chemistry
Nuclear Science & Engineering Corp.
Pittsburgh, Pa.

UTILIZATION of radioisotopes as tracers is predicated on the detection and/or measurement of the nuclear radiations emitted by radioactive isotopes in a chemical, physical, or biological system. Industrial tracing may be defined as the application of tracing methods to the problems of industry.

Estimates made by W. F. Libby, in a paper entitled "The Economic Aspects of Radioisotope Utiliza-

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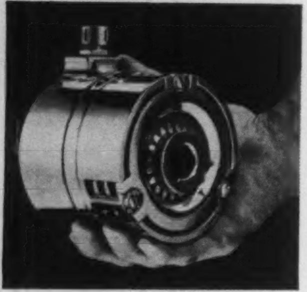

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Circle 711 on Page 17

Table 1—Estimated Annual Industrial Savings With Radioisotopes

Industrial Application	Annual Savings in Millions of Dollars: Probable Low	Probable High
Cigarette density gages	42.7	57.0
Metal thickness gages	18.5	27.8
Rubber and tire fabric thickness gages	8.0	20.3
Plastic and adhesive thickness gages	2.0	6.1
Paper and allied products thickness gages	23.1	24.9
Other thickness gages	2.3	6.9
Gages for liquid level, moisture, snow, etc.	2.5	7.6
Radiographic testing	28.7	64.6
Oil well logging	16.0	24.0
Oil well stimulation	120.0	180.0
Pipeline oil flow	0.5	0.7
Petroleum refining	5.3	10.1
Other applied industrial tracing	12.5	25.0
Tool wear studies	0.8	1.2
Piston ring and similar wear studies	12.0	18.0
Corrosion studies	3.0	4.6
Other industrial research	12.0	18.0
Luminescent sources	1.7	2.7
Miscellaneous industrial applications	0.5	0.8
Totals	312.1	500.3
Average	406.2	

tions" presented at the UNESCO Conference on Radioisotopes, Paris, France, September, 1957, indicate that industry is saving a total of approximately $400 million annually through the use of radioisotopes, TABLE 1. It is further estimated that these savings may be expected to reach about $5 billion in the next 4 or 5 years.

In an open letter to management, Dr. Libby made the observation that, up to June, 1957, only 1644 industrial firms had been licensed to use radioisotopes. This is only a small percentage of the total number of industrial organizations in the United States. Management was therefore enjoined to investigate the practical applications of radioisotopes and take advantage of the tremendous potential that exists for cost savings.

Types of Industrial Applications

Industrial application of radioisotopes implies that techniques are generally utilized by industry. It is convenient to divide these applications into three groups: 1. Industrial research and development. 2. Plant and field problems. 3. Process or quality control.

The first group of applications comprises those which may be performed conveniently in the research laboratory. Research and development programs may be made simpler, more sensitive, or completed earlier with the use of radioisotopes. Research with tracers is especially useful where the quantity of material involved is small, is difficult to separate or locate, or must be analyzed nondestructively. The largest number of industrial acquisitions of radioisotopes are for research and development purposes. Generally, these applications are small-scale in nature.

The second group of applications involves the use of radioactivity as an aid in solving plant or field problems. Because of size or volume considerations, these applications generally require larger initial quantities of radioactive materials. After tagging, however, the resultant material may contain very low concentrations of radioactivity. Leaks in underground storage areas, and leaks in oil well casings in bore holes, are easily found with radioactive tracers. Other examples of large-scale radioisotope tracing programs include the tracing of the paths of sewage and the tracing of sand and silt movements.

The third group of applications—process or quality control—is probably the most important one from the standpoint of industrial cost savings. This type of application may be subdivided into two methods of process automation or control. One method uses the radiations of isotopes for physical measurements, and the other utilizes them for tracing.

In measurement techniques, great strides are being made with thickness and height gages for continuous operations in manufacturing plants. Gages for the automatic production of sandpaper and for filling cigarettes are prominent examples.

The isotopic tracing method for quality or process control has received relatively little attention from industry. This is contrary to the fact that its potential for cost savings equals or exceeds that which has already been realized from other applications.

The method of product isotopic tracing is one which radioactivity, of a chemical nature compatible with the product being traced, is incorporated into the product. Control of the various processes involved is accomplished by following the radioactive product. This method is especially useful with low level radioactivity techniques. In general, such techniques are based on detecting levels of radioactivity which are little greater than the national radioactivities normally present.

Several applications of low-level counting have been made. These require special instrumentation to enhance the net activity-to-background ratio. The counters may be Geiger or scintillation types. Geiger counters use three types of shielding to reduce the background in these applications. First, a massive shield of steel absorbs any stray radiation in the environment. Second, a ring of anticoincidence counters reduces the effect of cosmic radiation. If a cosmic ray particle interacts in the low-level counter and creates a pulse, it is very likely that the same particle produces a pulse in going through one of the counters in the ring of anticoincidence counters. Such simultaneous pulses cancel each other electronically and are not recorded.

Finally, to remove the small quantity of gamma radiation present in the steel shield and the brass anticoincidence counters, purified mercury is placed around the Geiger counter. The background of such a counter ranges between 0.3 and 0.5 cpm. This background level can be reduced with further development effort.

In conclusion, industry should review and evaluate carefully the many industrial problems in existence today that may in some degree be solved by radioactive tracing methods. A broader program of industry education is needed on the uses of tracing techniques.

From a paper entitled "Radioisotope Utilization in Industrial Applications" sponsored by the American Nuclear Society for presentation at the Nuclear Engineering and Science Conference, Cleveland, April 1959.

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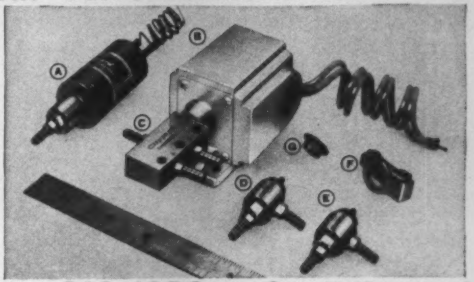

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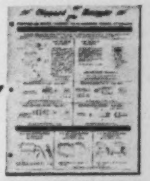

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Circle 713 on Page 17

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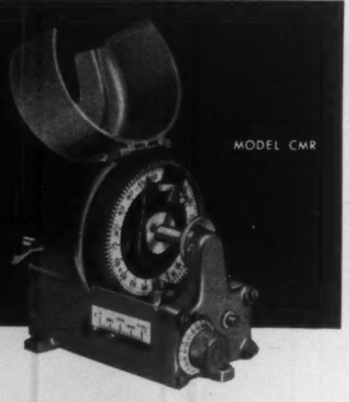

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Manager, Development Operations

Case 1853-P

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. . . This company manufactures pressure gages and dial type industrial thermometers. An integral part of each of these instruments is a movement. In the manufacture of these movements a number of assembly operations are performed. All of the operations are somewhat mechanized but it is our belief that automation could be employed. Are consulting organizations available in the Chicago area capable of recommending a course of action and perhaps designing and arranging for the building of automation equipment . . .

President

Case 1856-P

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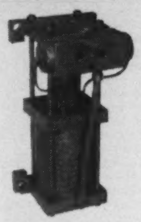

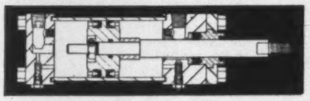

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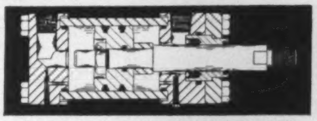

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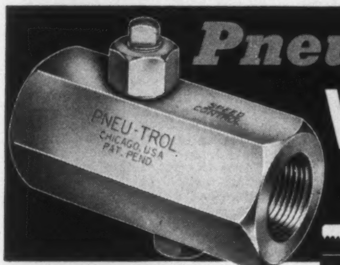

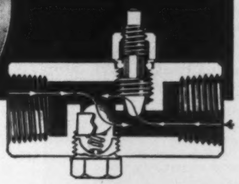

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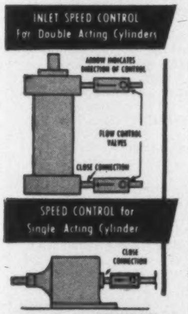
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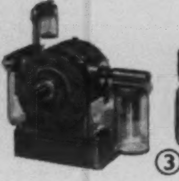

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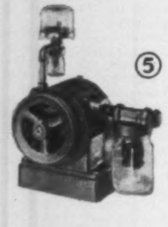

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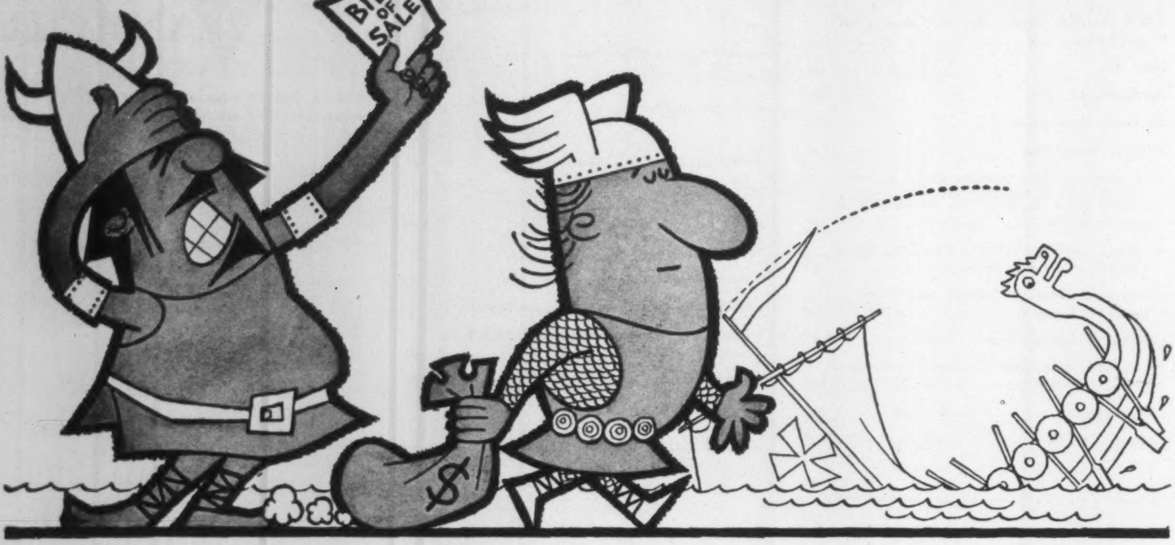

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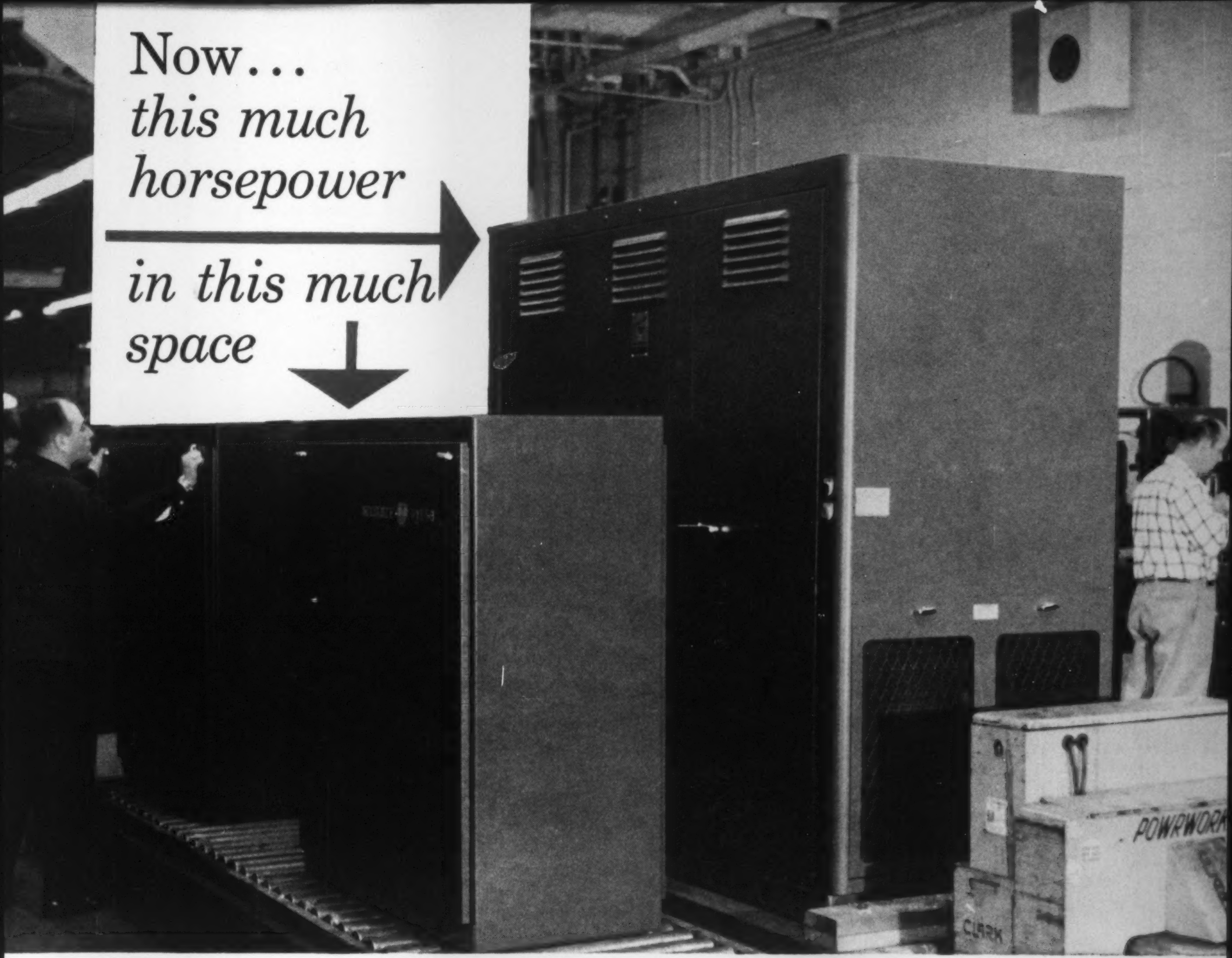

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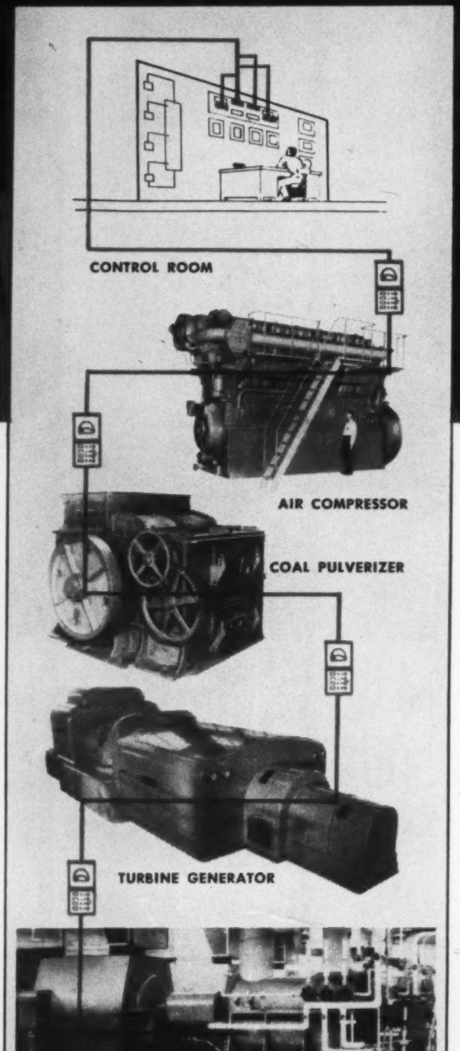

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